FARMERS' BULLETIN 1030

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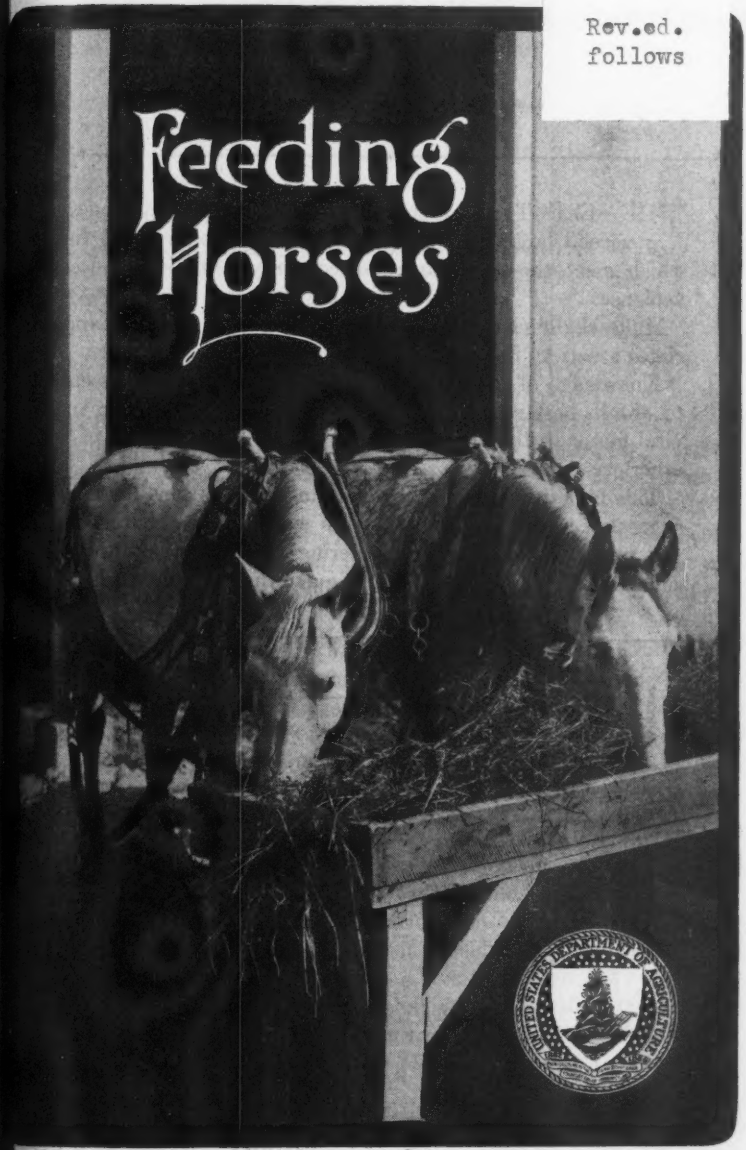
Feeding Horses



THE SELECTION of the most suitable ration for horses is governed largely by local conditions. Choose those feeds which meet the requirements of economy, nutrition, and convenience.

Make slight changes in feeds occasionally. A horse appreciates a variety in his diet.

Knowledge of individual requirements of horses is essential to obtain best results. Close observation is probably a more vital factor in the feeding of horses than in the feeding of any other class of live stock.

This bulletin explains the computation of rations for horses, suggests certain feed combinations which approximately meet the needs of horses under differing conditions, and reviews such factors of feeding as tend to make the horse more efficient.

Contribution from the Bureau of Animal Industry.

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FEEDING HORSES.

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STUDY OF RATIONS NECESSARY.

THE COMPUTATION of rations is valuable as a guide to the feeder for determining approximate rations from a large variety of feeds. It is useful, also, in determining the requisite amount of nutrients, so that each will be supplied without waste. Results in feeding a ration should be observed and the ration modified according to the age, size, and condition of the horse, and the amount and kind of work performed must determine the kind and quantity of feed to use.

There is far more economy in supplying the required amounts of nutrients in right proportion than in providing an excess of one and too little of another. Attention to balancing the rations of horses means a benefit to the animals and a saving in the enormous annual feed bill which is charged against the horses of the country.

LOCAL INFLUENCES IMPORTANT.

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, the crops grown locally constitute the most economical rations. Choose from the feeds available those that will meet most closely the requirements of economy, nutrition, and convenience. Substitution may often be made in rations in such a manner that while the efficiency remains unchanged, the cost is materially lowered. Selection of the most economical and suitable rations is governed largely by local conditions.

CONDITIONS AFFECTING FEED REQUIREMENTS

The kinds of feed used, the quantity per horse, and the manner of feeding depend on the age, size, and condition of the horse, the amount and kind of work, and on the individual animal.

The horse at work requires more and richer feed than the idle one. To furnish energy for work, feed must be in excess of that needed for bodily maintenance. The amount of feed needed for maintenance is about two-thirds that required by a horse at moderate work. If the work done calls for more energy than is furnished in the ration, the stored-up energy of the body fat or other bodily tissues, will be drawn upon with a consequent loss in body weight and energy. If such feeding is continued, the horse will be so weakened constitutionally that he will be unable to perform his work profitably and also will be especially liable to disease.

Individual horses of the same weight may have different feed requirements, which makes it necessary to study the individuality of the animals. If the horse is not doing well on a ration, a slight change should be made. Any change, however, should be made gradually in order to avoid digestive disturbances.

SELECTING A RATION.

As no feed or combination of feeds will meet conditions in all parts of the country, so no feed or mixture is suitable for all classes of horses. In choosing a ration for a horse, select the one that seems to meet his requirements, whether for growth, maintenance, work, breeding, or fattening; estimate the amount of feed needed and try out the ration. It may appear after a trial that too little is being fed or that the ration may be changed somewhat in the interest of economy or efficiency. If a number of horses are kept, different rations may be tested on different animals and the best one selected for general use. Individual feeding gives the best results.

BALANCING A RATION.

Feeding stuffs are broadly divided into two great classes, proteins and carbohydrates. The protein feeds are rich in nitrogenous compounds which are used in the animal body in building tissue, bone, hair, etc., and to provide energy; the carbohydrate feeds are starchy and are used in the animal body in the formation of fat and also for energy and heat.

To obtain the best results in feeding, the ration should be balanced properly to meet the needs of the animal in building tissue and supplying energy for work. In order to do this, the feeds containing the nutrients which supply the required proteins and energy are

needed in certain proportions to furnish the bodily requirements. If feeds deficient in protein are fed, an excessive amount must be consumed in order that the system may secure the required quantity of protein, and a waste of feed will be the result. It is essential, therefore, that a balanced ration be fed; that is, one containing protein and carbohydrates in such proportion that the requisite amounts of each will be received without waste.

The feeds rich in protein are usually the most expensive. If more protein is supplied than is needed for nutrition, the cost of the feed is unnecessarily increased. It is more economical to supply the energy necessary to perform work in the form of carbohydrates than as proteins; thus for mature horses at work and for maintaining body heat in cold weather, the protein feed allowance may be limited to the amount necessary to build tissue, and a large proportion of carbohydrates feed may be fed.

THE COMPUTATION OF RATIONS.[1]

The computation of rations is not difficult, and a little time spent on calculations enables the feeder to provide, from available feeds, a ration which will approximately supply the requisite amounts of protein and carbohydrates. Data on rations will afford valuable aid to the feeder, but he must observe results and modify his feeding accordingly.

The rations given in this publication are based on the true protein and the net energy values of various feeding stuffs. The net energy value is the measure of the true value of the feed as a source of energy to the animal organism after deducting the losses in the unburned materials in the excreta and the energy expended in extracting the real fuel materials from the feed consumed. For example, while 100 pounds of corn meal contain about 187 therms of chemical energy, only about 85 therms remain, after the above-mentioned deductions have been made, to represent the actual value of the meal as a source of energy to the animal.

The following table is adapted from a similar one published in Department Bulletin 459, previously mentioned, and gives the true protein and net energy values per 100 pounds of feeding stuffs for ruminants. It may be regarded as expressing with sufficient accuracy the relative values of feeding stuffs for horses. A column has been added designating the group in which some of the common feeds are ordinarily classified. This is done in order to simplify the selection of feeds for compounding a ration.

[1] For detailed information relative to the computation of rations, consult U. S. Department of Agriculture Bulletin 459, "The Use of Energy Values in the Computation of Rations for Farm Animals," by Henry Prentiss Armsby.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants.

Kind of feed.	Class.	Composition.		Net energy value.
		Dry matter.	Digestible true protein.	
DRIED ROUGHAGE.				
Hay and fodder from cereals.		*Pounds.*	*Pounds.*	*Therms.*
Brome grass, smooth	Carbohydrate.	91.5	3.5	40.83
Corn (maize) fodder (ears included, medium dry)	do	81.7	2.3	43.94
Corn (maize) stover (ears removed, medium dry)	do	81.0	1.6	31.62
Kafir fodder, high in water	do	71.7	1.8	34.28
Kafir stover, high in water	do	72.7	1.0	27.65
Millet, Hungarian	do	85.7	3.9	46.96
Timothy and clover mixed		87.8	3.6	40.85
Oat hay	Carbohydrate.	88.0	3.9	32.25
Orchard grass	do	88.4	3.3	44.93
Prairie hay	do	93.5	2.9	40.42
Red top	do	90.2	3.9	51.22
Sorghum fodder, computed to 80 per cent dry matter	do	80.0	1.5	32.20
Timothy, all analyses	do	88.4	2.2	43.02
Timothy, before bloom	do	92.8	2.9	43.52
Timothy, early to full bloom	do	87.2	2.5	47.40
Timothy, late bloom to early seed	do	85.1	1.8	37.54
Timothy, nearly ripe	do	87.5	1.8	38.59
Hay and fodder from legumes.				
Alfalfa, all analyses	Protein	91.4	7.1	34.23
Alfalfa, before bloom	do	93.8	10.3	36.23
Alfalfa, in bloom	do	92.5	6.7	32.33
Alfalfa, in seed	do	89.6	6.2	32.23
Clover, alsike	do	87.7	5.3	34.41
Clover, crimson	do	89.4	6.9	36.21
Clover, red, all analyses	do	87.1	4.9	38.69
Clover, red, before bloom	do	89.6	5.4	42.17
Clover, red, in bloom	do	86.1	5.3	39.12
Clover, red, after bloom	do	77.9	4.5	34.31
Clover, sweet white	do	91.4	6.7	38.98
Cowpeas, all analyses	do	90.3	9.2	37.39
Cowpeas, before bloom	do	92.2	12.8	33.58
Cowpeas, in bloom to early pod	do	89.4	9.5	39.11
Soy beans	do	91.4	8.8	44.03
Straws.				
Barley	Carbohydrate.	85.8	.6	36.61
Buckwheat	do	90.1	3.2	4.35
Oat	do	88.5	.8	34.81
Rice	do	92.5	.4	23.61
Rye	do	92.9	.5	17.79
Wheat	do	91.6	.3	7.23
FRESH GREEN ROUGHAGE.				
Green cereals, etc.				
Barley fodder		23.2	2.0	14.08
Bluegrass, Kentucky, before heading		23.8	2.8	14.52
Bluegrass, Kentucky, headed out		36.4	2.2	17.77
Bluegrass, Kentucky, after bloom		43.6	1.6	21.01
Buckwheat, Japanese		36.6	1.5	17.78
Cabbage		8.9	1.3	8.87
Cabbage, waste outer leaves		14.1	1.1	7.05
Corn (maize) fodder, dent, all analyses		23.1	.8	14.60
Corn (maize) fodder, dent, in tassel		14.9	.8	9.52
Corn (maize) fodder, dent, in milk		19.9	.8	13.64
Corn (maize) fodder, dent dough to glazing		25.1	1.0	17.35
Corn (maize) fodder, dent, kernels glazed		26.2	.8	16.74
Corn (maize) fodder, dent, kernels ripe		34.8	1.1	22.68
Corn (maize) fodder, flint, all analyses		20.7	.8	13.33
Corn (maize) fodder, flint, in tassel		10.6	.7	6.99
Corn (maize) fodder, flint, in milk		15.0	.7	10.39
Corn (maize) fodder, flint, kernels glazed		21.0	.8	13.69
Corn (maize) fodder, flint, kernels ripe		27.9	.9	17.94
Corn (maize) fodder, sweet, before milk stage		10.0	.6	7.23
Corn (maize) fodder, sweet, roasting ears or later		20.3	.9	13.18
Corn (maize) fodder, sweet, ears removed		21.5	.8	14.26
Millet, Hungarian		27.6	1.1	17.24

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued.

Kind of feed.	Class.	Composition.		Net energy value.
		Dry matter.	Digestible true protein.	
FRESH GREEN ROUGHAGE—continued.				
Green cereals, etc.—Continued.		*Pounds.*	*Pounds.*	*Therms.*
Oat fodder		26.1	2.0	14.06
Orchard grass		29.2	1.1	15.81
Rape		16.7	1.7	13.07
Rye fodder		21.3	1.4	15.99
Sweet sorghum fodder		24.9	.4	15.37
Timothy, before bloom		24.2	1.1	18.36
Timothy, in bloom		32.1	.8	18.89
Timothy, in seed		46.4	1.0	26.36
Wheat fodder		27.4	1.9	18.75
Green legumes.[1]				
Alfalfa, before bloom		19.9	1.9	9.20
Alfalfa, in bloom		25.9	1.8	11.50
Alfalfa, after bloom		29.8	1.3	11.10
Clover, alsike		24.3	1.5	14.56
Clover, crimson		17.4	1.6	10.83
Clover, red, all analyses		26.2	1.7	15.87
Clover, red, in bloom		27.5	1.8	16.74
Clover, red, rowen		34.4	2.2	17.30
Cowpeas		16.3	1.7	10.42
Peas, Canada field		16.6	2.1	9.78
Soy beans, all analyses		23.6	2.4	12.53
Soy beans, in bloom		20.8	2.3	10.44
Soy beans, in seed		24.2	2.5	12.70
Vetch, hairy		18.1	2.4	11.95
SILAGE.[1]				
Corn (maize), well-matured, recent analysis		26.3	.6	15.90
Corn (maize), immature		21.0	.4	11.96
Corn (maize), from frosted ears		25.3	.6	14.27
Corn (maize), from field-cured stover		19.6	.3	8.98
Clover		27.8	.8	7.26
Cowpeas		22.0	1.1	11.05
Soy beans		27.1	1.5	11.59
Sugar-beet pulp		10.0	.5	9.32
ROOTS, TUBERS, AND FRUITS.[1]				
Apples		18.2	.1	15.92
Beets, common		13.0	.1	7.84
Beets, sugar		16.4	.4	11.20
Carrots		11.7	.5	9.21
Mangels		9.4	.1	5.68
Potatoes		21.2	.1	18.27
Potato flakes		87.9	.4	72.68
Potato flour		89.4	.1	80.09
Pumpkins, field		8.3	.6	6.05
Rutabagas		10.9	.3	8.46
Turnips		9.5	.4	6.16
GRAINS.				
Cereal grains.				
Barley	Protein	90.7	8.3	89.94
Buckwheat	do	87.9	7.2	59.73
Corn (maize), dent	Carbohydrate	89.5	7.0	85.50
Corn (maize), flint	do	87.8	7.2	84.00
Corn (maize) and cob meal	do	89.6	5.7	75.80
Corn (maize) meal	do	88.7	6.4	85.20
Oats	Protein	90.8	8.7	67.56
Oatmeal	do	92.1	11.5	86.20
Rice, rough	Carbohydrate	90.4	4.5	77.33
Rye	Protein	90.6	9.0	93.71
Sorghum grain	Carbohydrate	87.3	6.7	89.75
Wheat, all analyses	Protein	89.8	8.1	91.82
Wheat, winter	do	89.1	7.7	91.66
Wheat, spring	do	89.9	8.1	91.41

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued.

Kind of feed.	Class.	Composition.		Net energy value.
		Dry matter.	Digestible true protein.	
GRAINS—continued.				
Leguminous seeds.		*Pounds.*	*Pounds.*	*Therms.*
Beans, navy	Protein	86.6	16.4	73.29
Cowpeas	do	88.4	16.9	79.46
Peas, field	do	90.8	16.6	78.72
Pea meal	do	89.1	17.2	77.62
Peanuts with hull	do	93.5	16.9	83.15
Peanut kernel	do	94.0	22.2	100.04
Soy beans	do	90.1	27.3	81.29
Oil seeds.				
Cottonseed	do	90.6	11.9	78.33
Flaxseed	do	90.8	19.2	83.17
Sunflower seed	do	95.5	20.2	95.77
Sunflower seed with hulls	do	93.1	11.7	92.49
DAIRY PRODUCTS.				
Buttermilk	do	9.4	3.4	13.32
Cow's milk	do	13.6	3.3	29.01
Skim milk—centrifugal	do	9.9	3.6	14.31
Skim milk—gravity	do	9.6	3.1	15.43
Skim milk—dried	do	91.7	34.4	103.91
Whey	Carbohydrate	6.6	.8	10.39
BY-PRODUCTS.				
Fermentation industries.				
Brewers' grains, dried	Protein	92.5	20.2	53.38
Brewers' grains, dried, below 25 per cent protein	do	91.8	17.5	50.93
Brewers' grains, wet	do	24.1	4.4	14.53
Distillers' grains, dried, from corn	do	93.4	18.3	85.08
Distillers' grains, dried, from rye	do	92.8	11.1	56.01
Distillers' grains, wet	do	22.6	2.8	22.05
Malt	do	94.2	11.8	87.82
Malt sprouts	do	92.4	12.5	72.72
Milling.				
Buckwheat bran	do	88.8	9.1	30.59
Buckwheat hulls	Carbohydrate	89.7	(8)	− 7.69
Buckwheat middlings	Protein	88.0	20.8	72.19
Hominy feed	Carbohydrate	89.9	6.5	88.78
Red-dog flour	Protein	88.9	13.2	78.80
Rice bran, high-grade	Carbohydrate	89.9	7.0	45.29
Rice meal	do	90.5	6.4	65.24
Rice polish	do	90.0	7.1	77.70
Rye bran	Protein	88.6	10.5	79.35
Wheat bran	do	89.9	10.8	53.00
Wheat middlings, flour	do	89.3	14.0	75.02
Wheat middlings, standard	do	89.6	12.0	59.10
Oil extraction.				
Coconut meal, low in fat	do	90.4	18.3	83.49
Coconut meal, high in fat	do	92.3	18.0	100.31
Cottonseed hulls	Carbohydrate	90.3	(8)	9.92
Cottonseed meal, choice	Protein	92.5	35.4	93.46
Cottonseed meal, prime	do	92.2	32.0	90.00
Germ oil meal, maize	do	91.1	14.3	83.88
Linseed meal, new process	do	90.4	30.9	85.12
Linseed meal, old process	do	90.9	28.5	88.91
Palm-nut cake	do	89.6	12.0	94.18
Peanut cake from hulled nuts	do	89.3	41.4	93.55
Peanut cake, hulls included	do	94.4	19.5	42.57
Soy-bean meal, fat extracted	do	88.2	37.3	99.65
Sunflower-seed cake	do	90.0	29.1	88.87
Starch manufacture.				
Gluten feed	do	91.3	20.1	80.72
Gluten meal	do	90.9	28.1	84.15
Starch feed, dry	Carbohydrate	90.7	9.2	77.46
Starch feed, wet	do	33.4	3.7	30.45

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued.

Kind of feed.	Class.	Composition.		Net energy value.
		Dry matter.	Digestible true protein.	
BY-PRODUCTS—continued.				
Sugar manufacture.		*Pounds.*	*Pounds.*	*Therms.*
Molasses, beet	Carbohydrate.	74.7	.....	57.10
Molasses, cane or black strap	....do.....	74.2	.....	55.38
Molasses beet pulp	....do.....	92.4	3.5	76.28
Sugar-beet pulp, dried	....do.....	91.8	.7	75.87
Sugar-beet pulp, ensiloed	....do.....	10.0	.5	9.32
Sugar-beet pulp, wet	....do.....	9.3	.5	8.99
Packing house.				
Dried blood	Protein.....	90.3	68.6	68.12
Tankage:				
Over 60 per cent protein	....do.....	92.6	55.6	93.04
55–60 per cent protein	....do.....	92.5	51.1	83.58
45–55 per cent protein	....do.....	92.5	45.5	72.96
Below 45 per cent protein	....do.....	93.5	35.6	54.16

REQUIREMENTS FOR WORK.

Rations containing the following amounts of digestible protein and of net energy value may be used as a guide in computing daily rations for the 1,000-pound work horse under varying conditions:

Kind of work.	Digestible protein.	Net energy value.
	Pounds.	*Therms.*
For light work	1.0	9.80
For medium work	1.4	12.40
For heavy work	2.0	16.00

(Dry matter: For the 1,000-pound horse, from 16 to 25 pounds is a fair average, depending on the amount of work performed.)

METHOD OF COMPUTING RATIONS.

Following is an example in computing a ration that will meet approximately the needs of a 1,000-pound horse or mule at medium work:

From the table above we know the requirement to be 1.4 pounds digestible protein and 12.4 therms of energy. A reasonable estimate for grain is that about $1\frac{1}{10}$ pounds per 100 pounds live weight is required, which would make a total of 11 pounds of grain daily for a 1,000-pound horse. A reasonable estimate for the amount of roughage is $1\frac{1}{2}$ pounds per 100 pounds live weight, which makes the requirement about 12 pounds of hay daily.

The next step is to list the available feeds; in this case let us assume that shelled corn, oats, alfalfa, and timothy hay are available.

From the list of analyses in the first table we know the composition of each of these feeds. The desired object is to combine the

feeds so that the total nutrients will be 1.4 pounds digestible protein and 12.4 therms of energy. The estimated amounts of grain and roughage are merely guides.

We first make a rough estimate of the amount of each feed necessary; then calculate the actual nutriment in the estimated amounts; and, lastly, make reductions, additions, or substitutions to the ration so that the total amount of nutrients will be very near 1.4 pounds of protein and 12.4 therms of energy.

For a trial ration let us take 7 pounds of oats and 4 pounds of corn for concentrates and 6 pounds each of alfalfa hay and timothy hay for roughages. According to the analyses, 100 pounds of oats have 8.7 pounds of true protein and 67.56 therms of energy. In our trial ration we are using 7 pounds of oats, which is $\frac{7}{100}$ of 100 pounds. Multiplying 8.7 and 67.56 by $\frac{7}{100}$, we find that in 7 pounds of oats there are 0.609 of a pound of protein and 4.7292 therms of energy. By similar use of the table we can determine the nutrients in the other feeds used in the estimated ration as follows:

Trial ration for 1,000-pound horse or mule at medium work.

Ration.	True protein.	Energy.
	Pounds.	*Therms.*
7 pounds oats	0.609	4.7292
4 pounds corn	.280	3.4200
6 pounds alfalfa hay	.426	2.0538
6 pounds timothy hay	.132	2.5812
Total	1.447	12.7842
Theoretical requirement	1.4	12.4

The computed ration is satisfactory in filling the theoretical requirements and has a slight margin of surplus. This is close enough for practical purposes.

If, in computing the nutrients in an estimated ration, the amount of protein is found to be low and the amount of net energy is high, there should be substituted a feed comparatively high in protein and low in energy; thus alfalfa hay sometimes may be substituted for timothy, or wheat bran may replace part of the corn in a ration.

It is not satisfactory to depend wholly upon grains and other concentrated feeds for furnishing nutrients to horses; neither will it do to provide only roughage. The horse has a relatively small stomach and can not take care of great quantities of coarse nonnutritious feed, but there must be sufficient bulk to the ration to make normal the process of digestion. Both concentrates and roughages are necessary.

FEED FOR LIGHT HORSES.

In horses of the light breeds that are used for pleasure or racing, the qualities desired are spirit, action, and endurance, and large, paunchy stomachs are objectionable. Such horses require proportionately

more grain and less hay than horses doing slow or heavy work. Oats easily rank first among the feeds for light horses; they may be supplemented with crushed or soaked barley and bran. Corn is too fattening to constitute the bulk of the concentrates for light horses; it may be used, however, if supplemented with linseed meal or bran. A mixture of one of the legume hays, as alfalfa or clover, fed with timothy or other hay, will furnish the roughage. A larger quantity of hay should be allowed for horses less actively employed and should be fed mostly at night. One pound of hay and 1 to 1¼ pounds of grain per 100 pounds live weight will be sufficient for such light horses at moderate work.

FEEDING WORK HORSES.

The quantity of feed for the work horse depends on the amount of work done and on the speed at which it is performed; a horse requires considerably more feed when working at the trot than at the walk. As before stated, it is a good rule to allow $1\frac{1}{10}$ pounds of grain and $1\frac{1}{5}$ pounds of hay per 100 pounds live weight for horses at moderate work. At this rate a 1,200-pound horse would require 13 pounds of grain and about 14½ pounds of hay per day. If the work is severe, the quantity of grain should be increased. The horse at hard work requires 1¼ to 1⅓ pounds of grain per 100 pounds live weight; the hay fed, however, should not be over 1¼ pounds per 100 pounds live weight. The exact quantity will depend largely on the individuality of each horse.

PRINCIPAL FEEDS FOR HORSES.

In connection with rations for horses a brief discussion of the merits of the more common feeds will assist in the choice of a ration. The nutrients contained in each feed may be ascertained by consulting the table of analyses. It is the special purpose of the following review to judge the feeds from the standpoint of the horse feeder.

For convenience the feeds will be classified as concentrates, roughages, succulent feeds, and condiments.

CONCENTRATES.

Oats.—This grain ranks as one of the very best for horses. The kernel is incased in a hull which adds to its value as a horse feed. It probably comes nearer filling the requirements of a concentrate for horses than any other single grain. Compared with corn, oats have more protein and less carbohydrates. Oats are readily available in almost every part of the country and may be fed either whole or ground. They should be rolled or ground for very young animals.

Some horses eat oats too rapidly. With such ravenous feeders, to prevent the danger of choking, it is advisable to place a little chopped clover hay or some whole corncobs in the feed box with the oats.

The use of wheat bran with oats also lessens the tendency toward choking. Oats may form the entire grain ration for horses. The substitution of 2 or 3 pounds of wheat bran improves the daily ration provided it does not produce a too laxative effect.

Corn.—In many sections corn is given preference over oats as a horse feed, as it is generally grown on the average farm or may be obtained easily. Corn may be fed on the cob or shelled or ground. It is especially rich in carbohydrates, and more energy is derived from a pound of corn than from a pound of any other suitable grain. It is considered as an economical part of a ration. Since this grain is somewhat low in protein it is well to provide leguminous hay for the animals that are fed corn. Alfalfa and corn are receiving much favor when fed together to horses. In the absence of legumes a little oil meal or other protein concentrate may be included in the ration. Corn is fattening, heat-producing, and is relished by horses.

It is sometimes claimed that horses which are fed corn are more subject to colic than those fed oats and other grains. Little difficulty in this line is experienced in the Corn Belt, where it is fed constantly. However, horses that have not been accustomed to eating corn should not be changed to it suddenly; in fact, changes in the horse ration should always be made gradually. Corn is suited to form the major part of the grain ration for horses if a nitrogenous (protein) roughage is fed.

Wheat bran.—This is a favorite feed among horsemen; it is especially palatable and is safe. A by-product of milling, it is usually somewhat expensive and is not always readily available. Wheat bran is quite laxative, and for this reason it is especially valuable for idle horses and for colts. With horses doing irregular work, the bowels may be aided by increasing or decreasing the allowance of bran. Because this feed is light and soft it makes a mixture of other feeds more suitable for feeding. Wheat bran is very nutritious; it is higher in protein than either oats or corn. However, it is not suited to form the entire concentrate ration for horses, but is very desirable to use in combination with other feeds.

Barley.—Barley is used as a principal grain for horses in many parts of the West. Except in physical character it is well suited to the horse ration. This grain should be rolled before being fed, but if finely ground it will form a pasty mass with the saliva of the mouth. Barley is a little higher in total nutrients than oats, but is not so widely used nor so generally popular a feed among horsemen. Rolled barley is suitable to form the major part of the grain ration for horses.

Rye.—This may be used as a horse feed in combination with other grains. In some regions it is an economical feed. It is even higher in total nutrients than oats. The grain is small and hard and should

be rolled or ground. Many horses will refuse whole rye when fed alone, and an abrupt change to rye is liable to produce colic. Most of the charges against rye may be traced to the feeding of moldy or otherwise damaged grain. It is probably better to limit the amount of rye to one-third of the grain ration. It may be mixed with ground corn, bran, oats, or other grains. Rye is not generally considered desirable to form a major part of the grain ration for horses, as it is not palatable when fed alone and is liable to cause digestive disturbances.

Buckwheat.—This grain is not very commonly used as a horse feed, although it is only a little below the more common cereals in nutrients. It has a characteristic, hard, black hull which has practically no value as a feed. Unadulterated buckwheat middlings are not easily obtained. They are made from that part of the kernel just beneath the woody hull and are very rich in protein. The middlings are usually mixed with the woody hulls and sold as buckwheat feed or buckwheat bran. This product has a lower feeding value than wheat bran. If the proportion of hulls is not too large, buckwheat bran may be well used in the horse ration. Buckwheat should be limited to one-third the grain ration.

Rice.—Rice is considered economical for horse feed in some of the Southern States, the less valuable rough rice being used. This grain is small and extremely hard; it should be ground or rolled before use in the horse ration. It is better to limit rough rice to one-third of the grain allowance. It may be used in connection with corn, blackstrap molasses, and a very limited allowance of some protein concentrate, such as cottonseed meal, soy-bean meal, or linseed meal.

Soy beans, cowpeas, velvet beans, horse beans, field peas.—All these are similar products of leguminous plants, and are suitable for use in limited amounts in the horse ration. Since all are hard seeds, they should always be ground. Their proper use in a ration for horses is as a somewhat concentrated protein feed to be combined with feeds high in carbohydrates, such as molasses and corn. Digestive troubles are very liable to occur if one or more of these feeds exceeds one-third of the concentrate ration. Used with care they have a very valuable place in horse feeding.

Coconut meal.—A by-product from the manufacture of coconut oil, it is considered a safe but rather unpalatable feed for horses. It is a little higher in nutrients than wheat bran, but has the disadvantage of becoming rancid after standing a few weeks. To the extent of one-fourth the grain ration, it may replace oats where economy justifies the measure. It is not a very heavy protein concentrate.

Peanuts.—In the form of peanut meal, this feed is often given to horses. The shelled nuts are liable to become rancid; the commercial

form of peanut meal is the ground hull and nut combined. It is a comparatively safe feed for horses, but is so rich in protein that the allowance should be limited. Animals should be started on this feed gradually. Peanut meal should be fed in connection with corn or some other carbonaceous feed.

Linseed meal.—This feed is the ground cake resulting after the oil has been extracted from flax seed. It is very high in protein, has laxative properties, but is not suited to form a bulk of the grain ration. Linseed meal is quite unpalatable, but is valuable, however, for combining with corn and other carbonaceous feeds, being a heavy protein concentrate. It is most successfully fed with ground feeds or in a mixture containing molasses, but if fed in combination with feeds from which it can be separated readily, horses will eat the palatable grains and refuse the meal. Some feeders use linseed meal as a conditioner, giving a small amount (about one-half pound) three times a week to keep the bowels in free condition. The more favorable results in the use of linseed meal are obtained when the quantity used is limited to 1 pound or less per day for each animal.

Shorts (wheat middlings).—This is not extensively used as a horse feed because it is usually high in price and its heavy nature and high protein content are not suited for the major part of the ration. However, it is palatable, and may be used to supplement a horse ration that is low in protein. The amount should be limited to one-fourth the concentrate allowance.

Cottonseed meal.—The resulting ground cake after the oil has been extracted from the cotton seed is a heavy protein concentrate, but unlike linseed meal is not laxative in character. This feed has met with considerable disfavor among horse feeders, as they claim it is liable to produce digestive disorders. There is, no doubt, some foundation to these claims, but it has been found that harmful results have usually followed the use of a poor quality of meal or when too much was fed. Cottonseed meal may be fed to horses in limited quantities if due care is exercised in obtaining bright, choice meal and the animals are put on the diet gradually. Its proper use is as a supplement to a carbonaceous ration, such as corn. Favorable results have been obtained in some parts of the South in the feeding of cottonseed meal in connection with blackstrap molasses and grain. Since the meal is not palatable, it should be well incorporated with other feeds. While cottonseed meal has been fed in large quantities in isolated cases, the best results may be obtained by limiting the amount to 1 pound daily per 1,000 pounds live weight, and giving special attention to the horses being fed.

Alfalfa meal.—Chopped alfalfa is often desirable to improve the physical character of a ration, but feeding alfalfa as a meal is not to be generally recommended. Alfalfa is a very valuable horse

feed but is properly classed among the roughages, even though it is higher in nutrients than some of the concentrates. Finely ground alfalfa is dusty and must be dampened before it can be fed with satisfaction. There is no advantage which justifies the additional cost of grinding, except for horses with bad teeth or weak digestive organs.

Millet, kafir, and milo seeds.—These are very small, hard grains which must be ground before they are suitable for the horse ration. They compare favorably with oats in regard to total nutrients, and any of them, when ground or rolled, may be used in combination with other grains, but it is well to limit the amount used to one-third the total concentrate allowance. The sorghum grains are high in carbohydrates and tend to cause constipation when fed heavily. These grains should be fed in conjunction with a laxative protein feed, such as wheat bran, to counteract this tendency.

Dried brewers' or distillers' grains.—These grains, which are by-products of fermentation industries, are rather heavy protein concentrates and suitable for balancing carbonaceous rations or for incorporation with chopped mixtures, but are not suitable for use as the major part of the grain ration. They are not palatable and should be limited in amount to about one-fourth the total allowance of concentrates. Some feeders claim that these feeds have a tendency to cause constipation.

Gluten meal.—A by-product of starch manufacture, it is high in protein and fairly high in carbohydrates. It is classed as a protein concentrate, and should be limited to about one-fourth the total grain allowance. It is not very palatable, but sometimes is valuable for use in chopped mixtures.

Gluten feed.—This is also a protein concentrate but is somewhat less nutritious than gluten meal. Gluten feed is made by mixing corn bran with gluten meal, and is not very palatable. The proper use of gluten feed is for balancing more carbonaceous rations, and it should be limited in amount to one-third of the grain ration. Like gluten meal, it may well be used with other grains in a chopped mixture and fed with molasses.

Dried beet pulp.—A by-product of sugar manufacture, this pulp is unpalatable, but by mixing with molasses or other well-liked feeds, it may be included in the ration. It is very low in protein. Dried beet-pulp is a safe feed, but it is not desirable to use it in excess of about 5 pounds in the daily ration, and it should be fed in connection with some feed that is relatively high in protein.

Cane molasses (blackstrap molasses).—The use of this feed is quite popular in cane-growing sections. It is high in carbohydrates and should be fed in connection with feeds relatively high in protein. Molasses is especially palatable and is well suited for combination

with chopped mixtures containing nutritious but unpalatable feeds. It is usually desirable to dilute it with two parts of water before feeding over grain or roughage. The amount of molasses in the ration should be limited. Usually about 5 pounds daily is a very reasonable allowance, although some feeders use considerably more than that amount. Cane molasses is neither laxative nor binding in effect. Molasses is not usually an economical feed except in sugar-producing regions. However, it is often desirable to use a small amount, such as a quart (3 pounds) a day, as an appetizer.

Beet molasses.—As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain constituents stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate ration that also includes a protein feed.

Milk.—Sometimes milk may be used with good results for feeding horses. Its particular advantage is in its use for colts and for horses that are out of condition. Milk may also be a valuable feed for horses doing very light work. It is palatable, easy to digest, and valuable for fattening. If cow's milk is to be substituted for mare's milk for young colts, there should be an addition of a little sugar and a little limewater. It is not desirable to feed a large quantity of milk to horses generally, but 3 or 4 gallons a day can well be allowed a horse not doing heavy work. Milk is a safe feed, and even in clabbered condition it is not harmful.

Tankage and blood meal.—These by-products of slaughterhouses do not rank high as horse feeds. They are very high in protein, but are extremely unpalatable. They may be used, however, in amounts not exceeding 1 pound each day per animal in connection with some palatable carbonaceous mixture. Tankage and blood meal are used principally for building up animals in extremely poor condition.

ROUGHAGES.

Alfalfa hay.—This roughage is receiving very great favor as a horse feed. It contains nearly as much nutriment, pound for pound, as wheat bran. It is very high in protein and minerals; hence it is especially valuable for young stock. Alfalfa is somewhat laxative in effect. Because of this and its high protein content, it is well to limit the amount to one-half or two-thirds the roughage allowance. Timothy hay may be used to make up the rest of the roughage supply. Alfalfa is especially suited for use with a grain ration that is low in protein. Corn as the grain, and alfalfa as the roughage, equal weights of each, very nearly make a balanced ration. In considering a roughage for horses, it is desirable to furnish one that is rela-

tively high in nutriment, since the horse has a comparatively small stomach and is unsuited to take care of great quantities of nonnutritious material. Alfalfa meets this requirement. Because of its soft stems this roughage is often used in chopped mixtures.

Timothy hay.—This hay is highly recommended for horses. Notwithstanding the fact that it is not very high in nutrients, there is probably no other one form of roughage that is better suited for the horse ration. It is low in protein and is suitable for combination with alfalfa, clover, or some other legume. If timothy is fed as the only form of roughage, the concentrate allowance should be relatively high in protein. Because of its sharp, brittle stems it is not well suited for use in chopped mixtures. It is readily available in most sections of the country. Timothy hay and oats have long been regarded as the standard horse feeds, but the combination can be improved by including some feed that is relatively high in protein.

Clover hay.—This is a good feed for horses. The usual criticism of this hay is that it is often dusty. Dampening at the time of feeding will aid somewhat, but proper care in the curing of the hay is the best means of preventing dust. Bright clover hay that is free from dust is almost as valuable as alfalfa. It is more palatable than timothy, and a mixture of clover and timothy is to be preferred to timothy alone as a roughage for horses. Clover is a legume and high in protein, somewhat laxative in effect, is an excellent feed for colts, and is suited for use in connection with a grain ration that is rather low in protein. Where only one kind of hay is fed, a little less quantity is required of clover than of timothy. Various kinds of clovers are used for hay in different parts of the country. Common red clover is most widely used. Mammoth or Big English clover is acceptable, but is somewhat coarse. The very coarse, large varieties, such as sweet clover, are usually too woody to be very desirable. Alsike is very good, but the yield of this crop is usually not large enough to encourage its growth in most localities. If hay from crimson clover is to be used as a horse feed, the crop should be cut before the blossoms are ripe, as the hairy growth on the head of the plant becomes wiry and indigestible and forms masses similar to hair balls in the digestive tract which often result in serious cases of impaction. Bur clover of the South may be used as a hay for horses, but its use is not common.

Corn stover.—Corn fodder from which the grain has been removed is a common feed for horses. The objections to it are that it is usually so carelessly handled that most of the nourishment is lost, and the feed is allowed to become partly spoiled. It is also unhandy to feed unless some special preparation is given, and there is usually considerable waste connected with feeding it. However, corn stover

that is bright and clean and which retains its leaves is very palatable, desirable, and safe for horses, and is suitable for use as the sole roughage during the fall and early winter. It is low in protein and should be fed in combination with a concentrate ration which will offset the deficiency. Cutting or shredding is usually advisable if it is to be fed in the stable.

Oat hay.—Hays from oats and similar cereals are commonly fed to horses. These crops should be cut before maturity if they are to be used as forage. They are palatable and nourishing, and care should be taken that the amount is limited. On account of the grain, the allowance should be about one-third less than would be fed in the case of the more common roughages. Very little concentrated feed is needed with oat hay, but it is desirable to include a feed relatively high in protein. Cereal hay may be fed as half the roughage allowance in connection with a legume hay. With such a combination only about half the usual grain ration is necessary.

Cowpeas, soy beans, velvet beans, and field peas.—These may be used as hay for horses. All are legumes, high in protein, and suitable for use in connection with concentrates that are high in carbohydrates, such as corn or molasses. The peas and beans are slightly laxative in effect. It is well to limit these feeds to one-half the roughage allowance; timothy or prairie hay may well be used to form the other half. The amount of grain in the pods should be taken into consideration, and the ration of concentrates should be reduced accordingly. Field-pea vines that have been carefully cured after the peas have been thrashed out are fairly acceptable as horse forage. A full grain ration and a little hay should be fed with them. Unthrashed cowpeas, soy beans, velvet beans, and field peas are fairly palatable and safe feeds, but are too concentrated to form the complete roughage allowance.

Millet, or Hungarian hay.—This is suitable for use in the horse ration, provided the crop has been cut before it is too mature and that an excessive quantity is not fed. The small, hard seeds of mature millet are objectionable, as harmful action on the kidneys is claimed when an excess of these is allowed. This hay is carbonaceous and should be fed in connection with a legume hay, or the concentrate allowance should contain feeds a little high in protein. Bright millet hay of fine growth is quite satisfactory as a horse feed when limited to half the roughage allowance.

Prairie hay.—This hay is satisfactory for use as a horse feed and is commonly used in the West. It is slightly lower in nutrients than timothy hay, is carbonaceous, should be fed in combination with a legume hay, and may form the total roughage allowance if the concentrate ration is sufficiently high in protein. It is a safe feed and fairly palatable.

Orchard-grass hay.—This grass makes a suitable hay for horses only when it is cut before maturity. It compares very favorably with timothy, and its palatability is not criticized in hay that is not too mature when cut. It is carbonaceous, and when used either the ration of concentrates should be high in protein or a legume hay should form part of the roughage allowance. It is a safe feed for horses.

Brome grass.—This grass is carbonaceous and common in the North and West. The hay is palatable and a safe feed for horses, a little low in protein, and the grain ration that is fed with it should include a protein concentrate.

Straw.—Straw from various cereals, such as oats, barley, wheat, rye, and rice, is often used as a feed for horses. It is bulky, nonnutritious, and is not especially suitable, since the horse has a comparatively small stomach and its digestive anatomy is in no way suited to handle a large amount of bulky feed. So very little nourishment is derived from straw that it is not considered a suitable feed for animals doing hard work. Straw is carbonaceous, and its principal use is for idle horses. Some laxative feed should be fed in connection with it. Because of economy, it is often desirable to feed some straw, and in this case the concentrate ration should be high in protein. A little straw may be included in a ration in which the principal roughage is alfalfa, clover, or some other legume. Oat straw is preferable; barley straw and wheat straw are good; straw from buckwheat or rye is not desirable; straw from rice is sometimes fed with good results when the remainder of the ration is high in protein. The economy of feeding straw is a factor which can not be disregarded, but the practice should not be carried to the extreme, and care should be taken to supply sufficient protein through the concentrate ration.

Vetch.—This legume is not in very common use as a horse feed. The plant is rich in nutrients, is suitable to form about half of the roughage allowance in a ration that is lacking in protein, and is fairly palatable. A combination that is meeting with favor is vetch and oat hay.

Sudan grass.—This plant makes a suitable hay for horses and is fairly palatable. As a carbonaceous feed the hay is suitable for use as part of the roughage allowance in combination with a legume hay. Its principal use is in the South.

Bermuda grass.—Hay from this plant is sometimes used in the South. It is a carbonaceous feed, suitable for use in connection with legume hay for the roughage allowance. If fed alone the concentrate allowance should be high in protein.

Sorghum.—Fodder from sorghum may be used as dry forage for horses but does not keep for a great length of time. It is especially high in carbohydrates, is palatable and suitable for use in connection with feeds which are high in protein.

SUCCULENT FEEDS.

Pasture.—Pasture is foremost among the succulent feeds for horses. It acts as a laxative and general tonic to the system, is an appetizer, and a valuable feed. Succulent feeds are watery and do not produce solid flesh. While pasture alone is sufficient to maintain idle horses, it is well to consider the relative feed value of the pasture crop and the general condition of the pasture. Usually it is advisable to feed a light grain ration relatively high in protein in connection with pasture, even when the horses are idle. Pasture is very valuable in the management of work teams; regularly allowing horses the freedom of pasture during the night and on idle days enhances the health of the animals. There will be an increased tendency toward sweating while at work but this is not of great importance when the benefits are considered. For work horses that are given pasture, other laxative feeds should be taken out of the ration. Timothy hay may be used as the roughage, and the concentrate ration should include grains that are not laxative in character, thus making a properly balanced ration. A necessary precaution is to avoid a sudden change to green feed; where a pasture crop is included in the ration for work horses, the practice should be continuous, not intermittent.

Soiling crops.—Most of the forage crops previously mentioned under "Roughages" may be cut green and fed to horses. This practice is probably most common with corn. Care should be taken, however, to prevent sudden changes to this type of green feed. There is also danger of the crop spoiling before being fed; therefore, the green feeds should be used only when fresh. The balancing in regard to nutrients should be the same for soiling crops as for pasture. The pasture system provides exercise and on this account is far preferable to soiling.

Roots.—Carrots, parsnips, rutabagas, and beets are succulent feeds used principally as an aid to digestion. Their use in the horse ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed other laxative feeds should be omitted, the roughage supply should be decreased, and the grain ration should contain feeds high in nutrients. Chopping the roots is usually advisable.

Potatoes.—Potatoes are relatively high in food value, are palatable, and are well suited for use as a horse feed where the cost is not prohibitive. It is safe to feed as high as 15 pounds a day to work horses. They are equivalent to about one-third their weight in hay. When potatoes are fed, a legume hay is a desirable supplement. If a carbonaceous hay is fed, the grain ration should contain feeds rich in protein. Potato sprouts are injurious to horses and should be

removed. It is advisable to chop potatoes before feeding, as the danger from choking is thereby lessened.

Fruits.—When without stones, fruits may be used for feed and are much relished by horses. This addition to the ration is as an appetizer and relish rather than as a nutritious feed. Fruits are low in protein, and if used in considerable amount the main ration should include protein feeds. Ten pounds of fruits daily are not harmful.

Pumpkins.—As a succulent feed for horses pumpkins have a fair value; their feeding value is about two-fifths that of silage, and their main use is for improving digestion. The seeds have a laxative effect. It is not advisable to feed pumpkins which have been frosted. They are not usually fed in great amount and should be limited to about 8 pounds daily. No other laxative feed should be included in the same ration, there should be a slight decrease in the amount of roughage, and provision should be made for feeds relatively high in nutrients to balance the ration.

Silage.—Silage should not be considered as one of the principal roughages for horses. Its use is as a succulent, an appetizer, and tonic to be fed in limited quantities as a supplement to the regular ration. When used, this feed must be introduced gradually into the ration. It is a very dangerous practice to feed molded or frozen silage to horses. Corn silage is the only kind that has met with any degree of favor as a horse feed. It has a valuable place in the winter ration if fed with care. The amount should not exceed 10 pounds daily per animal.

STOCK FEEDS AND CONDIMENTS.

The stock and condimental feeds that are generally bought on the market, which are represented to be conditioners, tonics, and fatteners, have for their foundation simple and well-known drugs and feeds. If a tonic or feed is desired, one of known composition may be mixed at home with entirely satisfactory results. The following formulas are suggested:

I.		II.	
Glauber salt	2 pounds.	Glauber salt	5 pounds.
Soda	1 pound.	Saltpeter	1½ pounds.
Salt	1 pound.	Fenugreek	1 pound.
Fenugreek	2 ounces.	Gentian	2 pounds.
Linseed meal	25 pounds.	Linseed meal	50 pounds.

A heaping tablespoonful of one of the above mixtures fed with the grain 3 times a day is sufficient.

When a tonic is needed it is advisable to investigate why it is needed. The horse should receive daily attention regarding feed, water, salt, exercise, grooming, sanitation, and comfortable quarters. Neglect of any of these factors is usually an underlying cause of the poor condition of an animal.

SUGGESTED DAILY RATIONS.

The following daily rations have been prepared with a view of suggesting combinations of feeds that will suit conditions in various parts of the country, and from which the feeder may derive rations that will meet his local needs. Attention is invited to the fact that the rations suggested are for a horse weighing 1,000 pounds, and modification of these rations should be made for heavier or lighter horses. For example, in order to meet the requirement for a horse weighing 1,250 pounds the rations suggested should be increased in accordance with the increase in weight, which in this case is 25 per cent. Roughly this would give the feed requirement for the heavier horse.

Maintenance ration for 1,000-pound idle horse.

[Theoretical daily requirement, 0.60 pound of protein and 7.30 therms of energy.]

Ration.	Protein.	Energy.
	Pounds.	*Therms.*
5 pounds ear corn	0.280	3.420
3 pounds alfalfa hay	.213	1.0269
9 pounds corn stover	.144	2.8458
	.637	7.2927
4 pounds oats	.348	2.7024
4 pounds clover hay	.196	1.5472
10 pounds oat straw	.08	3.481
	.624	7.7306
8 pounds alfalfa	.568	2.7384
8 pounds oat straw	.064	2.7848
3 pounds cane molasses	.000	1.6614
	.632	7.1846
5 pounds cowpea hay	.460	1.8795
5 pounds silage (corn)	.030	.7950
10 pounds timothy hay	.220	4.3020
	.710	6.9765
4 pounds rolled barley	.332	3.5976
4 pounds alfalfa hay	.284	1.3692
7 pounds barley straw	.042	2.5627
	.658	7.5295
4 pounds alfalfa hay	.284	1.3692
14 pounds corn fodder with ears	.322	6.1516
	.606	7.5208
2 pounds shelled corn	.140	1.710
4 pounds oat hay	.156	1.290
10 pounds orchard-grass hay	.330	4.493
	.626	7.493
3½ pounds shelled corn	.245	2.9925
3 pounds cowpea hay	.276	1.127
10 pounds oat straw	.08	3.481
	.601	7.60

Daily ration for 1,000-pound horse, very light work.

[Theoretical requirement, 1 pound protein and 9.80 therms energy.]

Ration.	Protein.	Energy.
	Pounds.	*Therms.*
10 pounds ear corn	0.56	6.840
5 pounds alfalfa hay	.355	1.711
5 pounds timothy hay	.110	2.151
	1.025	10.702
8 pounds oats	.696	5.4048
4 pounds alfalfa hay	.284	1.3692
6 pounds timothy hay	.132	2.5812
	1.112	9.3552
5 pounds shelled corn	.35	4.275
2 pounds cowpeas	.338	1.5892
½ pound cottonseed meal [1]	.177	.4672
5 pounds corn stover	.08	1.581
5 pounds sorghum fodder	.075	1.610
	1.02	9.5225
5 pounds cowpeas (coarsely ground)	.845	3.9730
5 pounds molasses	.000	2.7690
10 pounds oat straw	.080	3.481
	.925	10.223
8 pounds rolled barley	.664	7.1952
4 pounds alfalfa	.284	1.3692
5 pounds prairie hay	.145	2.021
	1.093	10.5854
7 pounds shelled corn	.490	5.985
1 pound cottonseed meal	.354	.9346
4 pounds cowpea hay	.368	1.5036
6 pounds corn stover	.096	1.8972
	1.308	10.3204
8 pounds shelled corn	.560	6.840
4 pounds cowpea hay	.368	1.5036
6 pounds corn stover	.096	1.8972
	1.024	10.2408

[1] The meal may be replaced by 1 pound of cowpeas.

Daily ration for 1,000-pound horse at medium work.

[Theoretical requirement, 1.40 pounds protein and 12.40 therms energy.]

Ration.	Protein.	Energy.
	Pounds.	*Therms.*
13 pounds ear corn	0.728	8.892
6 pounds alfalfa hay	.426	2.0538
7 pounds timothy hay	.154	3.0114
	1.308	13.9572
12 pounds oats	1.044	8.1072
1 pound cowpeas (cracked)	.169	.7946
11 pounds timothy	.242	4.7322
	1.455	13.6340

Daily ration for 1,000-pound horse at medium work—Continued.

Ration.	Protein.	Energy.
	Pounds.	*Therms.*
10 pounds rolled barley	0. 83	8. 9940
6 pounds alfalfa hay	. 426	2. 0538
5 pounds prairie hay	. 165	2. 021
	1. 421	13. 0688
11 pounds shelled corn	. 770	9. 405
6 pounds cowpea hay	. 552	2. 2554
6 pounds corn stover	. 096	1. 8972
	1. 418	13. 557
5 pounds cowpea hay	. 460	1. 8795
9 pounds corn stover	. 144	2. 8458
10 pounds shelled corn	. 700	8. 550
½ pound cottonseed meal	. 177	. 4673
	1. 48	13. 7426

Daily ration for 1,000-pound horse at severe work.

[Theoretical requirement, 2 pounds protein and 16 therms energy.]

Ration.	Protein.	Energy.
	Pounds.	*Therms.*
12 pounds oats	1. 044	8. 1072
2 pounds bran	. 216	1. 0600
8 pounds timothy hay	. 176	3. 4416
5 pounds clover hay	. 245	1. 9340
	1. 681	14. 5428
12 pounds shelled corn	. 840	10. 260
1 pound soy beans (ground)	. 273	. 8129
12 pounds alfalfa	. 852	4. 1076
4 pounds corn stover	. 084	1. 2648
	2. 049	16. 4453
7 pounds peanuts (ground with hull)	1. 183	5. 8205
7 pounds cane molasses	. 000	3. 8766
7 pounds pea hay	. 644	2. 6313
7 pounds timothy hay	. 154	3. 0114
	1. 981	15. 3428
10 pounds rolled barley	. 830	8. 9940
2 pounds gluten meal	. 562	1. 6830
8 pounds alfalfa	. 568	2. 7384
6 pounds prairie hay	. 174	2. 4252
	2. 134	15. 8406
5 pounds cowpea hay	. 460	1. 8795
9 pounds corn stover	. 144	2. 8458
13 pounds shelled corn	. 910	11. 115
1½ pounds cottonseed meal	. 531	1. 4019
	2. 045	17. 2422

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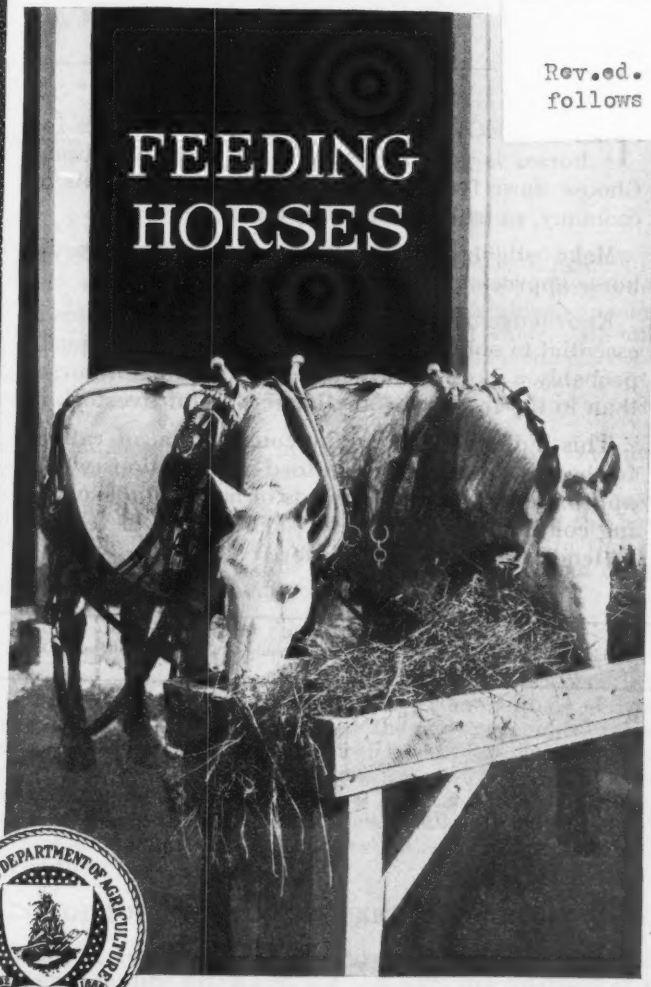
FEEDING HORSES



THE SELECTION of the most suitable ration for horses is governed largely by local conditions. Choose those feeds which meet the requirements of economy, nutrition, and convenience.

Make slight changes in feeds occasionally. A horse appreciates a variety in his diet.

Knowledge of individual requirements of horses is essential to obtain best results. Close observation is probably a more vital factor in the feeding of horses than in the feeding of any other class of livestock.

This bulletin explains the computation of rations for horses, suggests certain feed combinations which approximately meet the needs of horses under varying conditions, and reviews such factors of feeding as tend to make the horse more efficient.

Washington, D. C. Issued December, 1916; revised November, 1924

FEEDING HORSES

By G. A. BELL, *formerly Senior Animal Husbandman*,[1] and J. O. WILLIAMS, *Senior Animal Husbandman in Horse and Mule Investigations, Animal Husbandry Division, Bureau of Animal Industry.*

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STUDY OF RATIONS NECESSARY

THE COMPUTATION of rations is valuable as a guide to the feeder in determining approximate rations from a large variety of feeds. It is useful, also, in determining the requisite amount of nutrients, so that each will be supplied without waste. Results in feeding a ration should be observed and the ration modified according to the age, size, and condition of the horse. The amount and kind of work performed will determine the kind and quantity of feed to use.

There is far more economy in supplying the required amounts of nutrients in the right proportions than in providing an excess of one and a deficiency of another. Proper attention given to the matter of balancing horse rations will result in benefit to both the health and the working efficiency of the animals fed, which in turn will effect a material reduction in the enormous annual feed bill charged against the horses of the country.

LOCAL INFLUENCES IMPORTANT

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, combinations of home-grown or locally raised crops constitute the most economical rations. Choose from the feeds available those which will most closely meet the requirements of economy, nutrition, and convenience. Substitution may often be made in rations in such a manner that, while the efficiency remains unchanged, the cost is materially lowered. Selection of the most economical and suitable ration is governed largely by local conditions.

CONDITIONS AFFECTING FEED REQUIREMENTS

The kinds of feed used, the quantity required per animal, and the manner of feeding depend on the age, size, and condition of the horse, the amount and kind of work done, and the individual fed.

[1] Mr. Bell resigned from the department October 15, 1920.

The horse at work requires more and richer feed than the idle one. To furnish energy for work, the feed allowance must be in excess of that needed for body maintenance. The amount of feed needed for maintenance is about two-thirds that required for a horse at moderate work. If the work done calls for more energy than is furnished in the ration, the stored-up energy of the body fat or other tissues will be drawn on, with a consequent loss in body weight and energy. If such feeding practice is continued, the horse will be so weakened constitutionally that he will be unable to perform his work profitably and also will be especially susceptible to disease.

Horses of the same type and weight may have different feed requirements, which makes it necessary to study the individuality of the animals. If the horse is not doing well on a ration, a slight change should be made. Any change, however, should be made gradually in order to avoid digestive disturbances.

SELECTING A RATION

As no feed or combination of feeds will meet conditions in all parts of the country, so no feed or mixture of feeds is suitable for all classes of horses. In choosing a ration for a horse, select the one that seems to meet best his requirements, whether for growth, maintenance, work, breeding, or fattening; estimate the amount of feed needed, and try out the ration. It may appear after a trial that too little is being fed or that the ration may be changed somewhat in the interest of either economy or efficiency. If a number of horses are kept, different rations may be tested on different animals and the best one selected for general use. Individual feeding gives the best results.

BALANCING A RATION

Feeding stuffs are broadly divided into two great classes, protein and carbohydrate. The protein feeds are rich in nitrogenous compounds which are used by the animal body in building tissue, bone, hair, etc., and to provide energy. The carbohydrate feeds are starchy in nature and are used by the animal body in the formation of fat and for energy and heat.

To obtain the best results in feeding, the ration should be so balanced that it properly meets the needs of the animal in building tissue and in supplying energy for work. In order to do this, feeds containing the nutrients which supply the required proteins and energy are needed in certain proportions to meet the body requirements. If feeds deficient in protein are fed, an excessive amount of carbonaceous nutrients must be consumed in order that the system may obtain the required quantity of protein, and vice versa, and so a waste of feed will be the result. It is essential, therefore, that a balanced ration be fed; that is, one containing proteins and carbohydrates in such proportions that the requisite amounts of each will be utilized without waste.

Feeds rich in protein are usually the most expensive. If more protein is supplied than is needed for nutrition, the cost of the feed is unnecessarily increased. It is more economical to supply the energy necessary to perform work in the form of carbohydrates than proteins. Thus for mature horses at work and for maintaining idle

horses the protein feed allowance may be limited to the amount necessary to build tissue, and a large proportion of carbohydrates may be fed.

THE COMPUTATION OF RATIONS [2]

The computation of rations is not difficult, and a little time spent on calculations enables the feeder to provide, from available feeds, a ration which will approximately supply the requisite amounts of protein and carbohydrates. Data on rations will afford valuable aid to the feeder, but he must observe results and modify his feeding accordingly.

The rations given in this publication are based on the true protein and the net energy values of various feeding stuffs. The net energy value is the measure of the true value of the feed as a source of energy to the animal organism after deducting the losses in the unburned materials in the excreta and the energy expended in extracting the real fuel materials from the feed consumed. For example, while 100 pounds of corn meal contain about 187 therms of chemical energy, only about 85 therms remain, after the above-mentioned deductions have been made, to represent the actual value of the meal as a source of energy to the animal.

The following table is adapted from a similar one published in Department Bulletin 459, and gives the true protein and net energy values per 100 pounds of feeding stuffs for ruminants. It may be regarded as expressing with sufficient accuracy the relative values of feeding stuffs for horses. A column has been added designating the group in which some of the common feeds are ordinarily classified. This is done in order to simplify the selection of feeds for compounding a ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DRIED ROUGHAGE				
Hay and fodder from cereals		*Pounds*	*Pounds*	*Therms*
Brome grass, smooth	Carbohydrate.	91.5	3.5	40.83
Corn (maize) fodder (ears included, medium dry)	do	81.7	2.3	43.94
Corn (maize) stover (ears removed, medium dry)	do	81.0	1.6	31.62
Kafir fodder, high in water	do	71.7	1.8	34.28
Kafir stover, high in water	do	72.7	1.0	27.65
Millet, Hungarian	do	85.7	3.9	46.96
Timothy and clover mixed		87.8	3.6	40.85
Oat hay	Carbohydrate.	88.0	3.9	32.25
Orchard grass	do	88.4	3.3	44.93
Prairie hay	do	93.5	2.9	40.42
Red top	do	90.2	3.9	51.22
Sorghum fodder, computed to 80 per cent dry matter	do	80.0	1.5	32.20
Timothy, all analyses	do	88.4	2.2	43.02
Timothy, before bloom	do	92.8	2.9	43.52
Timothy, early to full bloom	do	87.2	2.5	47.40
Timothy, late bloom to early seed	do	85.1	1.8	37.54
Timothy, nearly ripe	do	87.5	1.8	38.59

[2] For detailed information relative to the computation of rations, consult U. S. Department of Agriculture Bulletin 459, "The Use of Energy Values in the Computation of Rations for Farm Animals," by Henry Prentiss Armsby.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DRIED ROUGHAGE—continued				
Hay and fodder from legumes		*Pounds*	*Pounds*	*Therms*
Alfalfa, all analyses	Protein	91.4	7.1	34.23
Alfalfa, before bloom	do	93.8	10.3	36.23
Alfalfa, in bloom	do	92.5	6.7	32.33
Alfalfa, in seed	do	89.6	6.2	32.23
Clover, alsike	do	87.7	5.3	34.42
Clover, crimson	do	89.4	6.9	36.21
Clover, red, all analyses	do	87.1	4.9	38.68
Clover, red, before bloom	do	89.6	5.4	42.17
Clover, red, in bloom	do	86.1	5.3	39.12
Clover, red, after bloom	do	77.9	4.5	34.51
Clover, sweet white	do	91.4	6.7	38.98
Cowpeas, all analyses	do	90.3	9.2	37.59
Cowpeas, before bloom	do	92.2	12.8	33.54
Cowpeas, in bloom to early pod	do	89.4	9.5	39.11
Soybeans	do	91.4	8.8	44.03
Straws				
Barley	Carbohydrate	85.8	.6	36.61
Buckwheat	do	90.1	3.2	4.55
Oat	do	88.5	.8	34.81
Rice	do	92.5	.4	23.63
Rye	do	92.9	.5	17.59
Wheat	do	91.6	.3	7.22
FRESH GREEN ROUGHAGE				
Green cereals, etc.				
Barley fodder		23.2	2.0	14.08
Bluegrass, Kentucky, before heading		23.8	2.8	14.82
Bluegrass, Kentucky, headed out		36.4	2.2	17.77
Bluegrass, Kentucky, after bloom		43.6	1.6	21.01
Buckwheat, Japanese		36.6	1.5	17.78
Cabbage		8.9	1.3	8.87
Cabbage, waste outer leaves		14.1	1.1	7.05
Corn (maize) fodder, dent, all analyses		23.1	.8	14.60
Corn (maize) fodder, dent, in tassel		14.9	.8	9.52
Corn (maize) fodder, dent, in milk		19.9	.8	13.64
Corn (maize) fodder, dent, dough to glazing		25.1	1.0	17.35
Corn (maize) fodder, dent, kernels glazed		26.2	.8	16.74
Corn (maize) fodder, dent, kernels ripe		34.8	1.1	22.48
Corn (maize) fodder, flint, all analyses		20.7	.8	13.53
Corn (maize) fodder, flint, in tassel		10.6	.7	6.89
Corn (maize) fodder, flint, in milk		15.0	.7	10.39
Corn (maize) fodder, flint, kernels glazed		21.0	.8	13.49
Corn (maize) fodder, flint, kernels ripe		27.9	.9	17.84
Corn (maize) fodder, sweet, before milk stage		10.0	.6	7.82
Corn (maize) fodder, sweet, roasting ears or later		20.3	.9	13.38
Corn (maize) fodder, sweet, ears removed		21.5	.8	14.26
Millet, Hungarian		27.6	1.1	17.24
Oat fodder		26.1	2.0	14.06
Orchard grass		29.2	1.1	15.81
Rape		16.7	1.7	13.07
Rye fodder		21.3	1.4	15.99
Sweet sorghum fodder		24.9	.4	15.37
Timothy, before bloom		24.2	1.1	18.36
Timothy, in bloom		32.1	.8	18.89
Timothy, in seed		46.4	1.0	26.36
Wheat fodder		27.4	1.9	18.75
Green legumes [1]				
Alfalfa, before bloom		19.9	1.9	9.20
Alfalfa, in bloom		25.9	1.8	11.50
Alfalfa, after bloom		29.8	1.3	11.10
Clover, alsike		24.3	1.5	14.56
Clover, crimson		17.4	1.6	10.83
Clover, red, all analyses		26.2	1.7	15.87
Clover, red, in bloom		27.5	1.8	16.74
Clover, red, rowen		34.4	2.2	17.30

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
FRESH GREEN ROUGHAGE—continued				
Green legumes—Continued		*Pounds*	*Pounds*	*Therms*
Cowpeas		16.3	1.7	10.42
Peas, Canada field		16.6	2.1	9.78
Soybeans, all analyses		23.6	2.4	12.53
Soybeans, in bloom		20.8	2.3	10.44
Soybeans, in seed		24.2	2.5	12.70
Vetch, hairy		18.1	2.4	11.95
SILAGE [1]				
Corn (maize), well-matured, recent analysis		26.3	.6	15.90
Corn (maize), immature		21.0	.4	11.96
Corn (maize), from frosted ears		25.3	.6	14.27
Corn (maize), from field-cured stover		19.6	.3	8.98
Clover		27.8	.8	7.26
Cowpeas		22.0	1.1	11.05
Soybeans		27.1	1.5	11.59
Sugar-beet pulp		10.0	.5	9.32
ROOTS, TUBERS, AND FRUITS [1]				
Apples		18.2	.1	15.92
Beets, common		13.0	.1	7.84
Beets, sugar		16.4	.4	11.20
Carrots		11.7	.5	9.21
Mangels		9.4	.1	5.68
Potatoes		21.2	.1	18.27
Potato flakes		87.9	.4	72.68
Potato flour		89.4	.1	80.09
Pumpkins, field		8.3	.6	6.05
Rutabagas		10.9	.3	8.46
Turnips		9.5	.4	6.16
GRAINS				
Cereal grains				
Barley	Protein	90.7	8.3	89.94
Buckwheat	do	87.9	7.2	59.73
Corn (maize), dent	Carbohydrate	89.5	7.0	85.50
Corn (maize), flint	do	87.8	7.2	84.00
Corn (maize) and cob meal	do	89.6	5.7	75.80
Corn (maize) meal	do	88.7	6.4	85.20
Oats	Protein	90.8	8.7	67.56
Oatmeal	do	92.1	11.5	86.20
Rice, rough	Carbohydrate	90.4	4.5	77.33
Rye	Protein	90.6	9.0	93.71
Sorghum grain	Carbohydrate	87.3	6.7	89.75
Wheat, all analyses	Protein	89.8	8.1	91.82
Wheat, winter	do	89.1	7.7	91.66
Wheat, spring	do	89.9	8.1	91.41
Leguminous seeds				
Beans, navy	do	86.6	16.4	73.29
Cowpeas	do	88.4	16.9	79.46
Peas, field	do	90.8	16.6	78.72
Pea meal	do	89.1	17.2	77.62
Peanuts with hull	do	93.5	16.9	83.15
Peanut kernel	do	94.0	22.2	109.04
Soybeans	do	90.1	27.3	81.29
Oil seeds				
Cottonseed	do	90.6	11.9	78.33
Flaxseed	do	90.8	19.2	83.17
Sunflower seed	do	95.5	20.2	95.77
Sunflower seed with hulls	do	93.1	11.7	92.49

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DAIRY PRODUCTS		*Pounds*	*Pounds*	*Therms*
Buttermilk	Protein	9.4	3.4	13.32
Cow's milk	do	13.6	3.3	29.01
Skim milk—centrifugal	do	9.9	3.6	14.31
Skim milk—gravity	do	9.6	3.1	15.43
Skim milk—dried	do	91.7	34.4	103.91
Whey	Carbohydrate	6.6	.8	10.39
BY-PRODUCTS				
Fermentation industries				
Brewers' grains, dried	Protein	92.5	20.2	53.38
Brewers' grains, dried, below 25 per cent protein	do	91.8	17.5	50.93
Brewers' grains, wet	do	24.1	4.4	14.53
Distillers' grains, dried, from corn	do	93.4	18.3	85.08
Distillers' grains, dried, from rye	do	92.8	11.1	56.01
Distillers' grains, wet	do	22.6	2.8	22.05
Malt	do	94.2	11.8	87.82
Malt sprouts	do	92.4	12.5	72.72
Milling				
Buckwheat bran	do	88.8	9.1	30.59
Buckwheat hulls	Carbohydrate	89.7		−7.69
Buckwheat middlings	Protein	88.0	20.8	72.19
Hominy feed	Carbohydrate	89.9	6.5	88.78
Red-dog flour	Protein	88.9	13.2	78.80
Rice bran, high-grade	Carbohydrate	89.9	7.0	45.29
Rice meal	do	90.5	6.4	65.24
Rice polish	do	90.0	7.1	77.70
Rye bran	Protein	88.6	10.5	79.35
Wheat bran	do	89.9	10.8	53.00
Wheat middlings, flour	do	89.3	14.0	75.02
Wheat middlings, standard	do	89.6	12.0	59.10
Oil extraction				
Coconut meal, low in fat	do	90.4	18.3	83.49
Coconut meal, high in fat	do	92.3	18.0	100.31
Cottonseed hulls	Carbohydrate	90.3		9.92
Cottonseed meal, choice	Protein	92.5	35.4	93.46
Cottonseed meal, prime	do	92.2	32.0	90.00
Germ oil meal, maize	do	91.1	14.3	83.88
Linseed meal, new process	do	90.4	30.9	85.12
Linseed meal, old process	do	90.9	28.5	88.91
Palm-nut cake	do	89.6	12.0	94.18
Peanut cake from hulled nuts	do	89.3	41.4	93.55
Peanut cake, hulls included	do	94.4	19.5	42.57
Soybean meal, fat extracted	do	88.2	37.3	99.65
Sunflower-seed cake	do	90.0	29.1	88.87
Starch manufacturing				
Gluten feed	do	91.3	20.1	80.72
Gluten meal	do	90.9	28.1	84.15
Starch feed, dry	Carbohydrate	90.7	9.2	77.46
Starch feed, wet	do	33.4	3.7	30.45
Sugar manufacture				
Molasses, beet	do	74.7		57.10
Molasses, cane or blackstrap	do	74.2		55.38
Molasses beet pulp	do	92.4	3.5	76.28
Sugar-beet pulp, dried	do	91.8	.7	75.87
Sugar-beet pulp, ensiled	do	10.0	.5	9.32
Sugar-beet pulp, wet	do	9.3	.5	8.99
Packing house				
Dried blood	Protein	90.3	68.6	68.12
Tankage:				
Over 60 per cent protein	do	92.6	55.6	93.04
55–60 per cent protein	do	92.5	51.1	83.58
45–55 per cent protein	do	92.5	45.5	72.96
Below 45 per cent protein	do	93.5	35.6	54.16

REQUIREMENTS FOR WORK

Rations containing the following amounts of digestible protein and of net energy value may be used as a guide in computing daily rations for the 1,000-pound work horse under varying conditions:

Kind of work	Digestible protein	Net energy value
	Pounds	*Therms*
For light work	1.0	9.80
For medium work	1.4	12.40
For heavy work	2.0	16.00

(Dry matter: For the 1,000-pound horse, from 16 to 25 pounds is a fair average, depending on the amount of work performed.)

METHOD OF COMPUTING RATIONS

Following is an example in computing a ration that will meet approximately the needs of a 1,000-pound horse or mule at medium work:

From the table above we know the requirement to be 1.4 pounds digestible protein and 12.4 therms of energy. A reasonable estimate for grain is that about $1\frac{1}{10}$ pounds per 100 pounds live weight is required, which would make a total of 11 pounds of grain daily for a 1,000-pound horse. A reasonable estimate for the amount of roughage is $1\frac{1}{5}$ pounds per 100 pounds live weight, which makes the requirement about 12 pounds of hay daily.

The next step is to list the available feeds; in this case let us assume that shelled corn, oats, alfalfa, and timothy hay are available.

From the list of analyses in the first table we know the composition of each of these feeds. The desired object is to combine the feeds so that the total nutrients will be 1.4 pounds digestible protein and 12.4 therms of energy. The estimated amounts of grain and roughage are merely guides.

We first make a rough estimate of the amount of each feed necessary; then calculate the actual nutriment in the estimated amounts; and, lastly, make reductions, additions, or substitutions to the ration so that the total amount of nutrients will be very near 1.4 pounds of protein and 12.4 therms of energy.

For a trial ration let us take 7 pounds of oats and 4 pounds of corn for concentrates and 6 pounds each of alfalfa hay and timothy hay for roughages. According to the analyses, 100 pounds of oats have 8.7 pounds of true protein and 67.56 therms of energy. In our trial ration we are using 7 pounds of oats, which is $\frac{7}{100}$ of 100 pounds. Multiplying 8.7 and 67.56 by $\frac{7}{100}$, we find that in 7 pounds of oats there are 0.609 of a pound of protein and 4.7292 therms of energy. By similar use of the table we can determine the nutrients in the other feeds used in the estimated ration as follows:

Trial ration for 1,000-pound horse or mule at medium work

Ration	True protein	Energy
	Pounds	*Therms*
7 pounds oats	0. 609	4. 7292
4 pounds corn	. 280	3. 4200
6 pounds alfalfa hay	. 426	2. 0538
6 pounds timothy hay	. 132	2. 5812
Total	1. 447	12. 7842
Theoretical requirement	1. 4	12. 4

The computed ration is satisfactory in filling the theoretical requirements and has a slight margin of surplus. This is close enough for practical purposes.

If, in computing the nutrients in an estimated ration, the amount of protein is found to be low and the amount of net energy is high, there should be substituted a feed comparatively high in protein and low in energy; thus alfalfa hay sometimes may be substituted for timothy, or wheat bran may replace part of the corn in a ration.

It is not satisfactory to depend wholly upon grains and other concentrated feeds for furnishing nutrients to horses; neither will it do to provide only roughage. The horse has a relatively small stomach and can not take care of great quantities of coarse, nonnutritious feed, but there must be sufficient bulk to the ration to make normal the process of digestion. Both concentrates and roughages are necessary.

FEED FOR LIGHT HORSES

In horses of the light breeds that are used for pleasure or racing, the qualities desired are spirit, action, and endurance, and large, paunchy stomachs are objectionable. Such horses require proportionately more grain and less hay than horses doing slow or heavy work. Oats easily rank first among the feeds for light horses; they may be supplemented with crushed or soaked barley and bran. Corn is too fattening to constitute the bulk of the concentrates for light horses; it may be used, however, if supplemented with linseed meal or bran. A mixture of one of the legume hays, as alfalfa or clover, fed with timothy or other hay, will furnish the roughage. A larger quantity of hay should be allowed for horses less actively employed and should be fed mostly at night. One pound of hay and 1 to 1¼ pounds of grain per 100 pounds live weight will be sufficient for such light horses at moderate work.

FEEDING WORK HORSES

The quantity of feed for the work horse depends on the amount of work done and on the speed at which it is performed; a horse requires considerably more feed when working at the trot than at the walk. As before stated, it is a good rule to allow 1 1/10 pounds of grain and 1⅕ pounds of hay per 100 pounds live weight for horses at moderate work. At this rate a 1,200-pound horse would require 13 pounds of grain and about 14½ pounds of hay per day. If the work is severe, the quantity of grain should be increased. The horse at hard work requires 1¼ to 1⅓ pounds of grain per 100 pounds live weight; the hay fed, however, should not be over 1¼ pounds per 100 pounds live weight. The exact quantity will depend largely on the individuality of each horse.

PRINCIPAL FEEDS FOR HORSES

In connection with rations for horses a brief discussion of the merits of the more common feeds will assist in the choice of a ration. The nutrients contained in each feed may be ascertained by consulting the table of analyses. It is the special purpose of the following review to judge the feeds from the standpoint of the horse feeder.

For convenience the feeds will be classified as concentrates, roughages, succulent feeds, and condiments.

CONCENTRATES

Oats.—This grain ranks as one of the very best for horses. The kernel is incased in a hull which, although it has no great nutritive value, greatly improves the physical character of the feed by adding bulk. Oats probably come nearer to filling the requirements of a concentrate for horses than any other grain. Compared with corn, oats have more protein and less carbohydrates. Oats are readily available in almost every part of the country and may be fed either whole or ground. They should be rolled or ground for very young animals.

Some horses eat oats too rapidly. With such ravenous feeders, to prevent the danger of choking, it is advisable to place a little chopped clover hay or some whole corncobs in the feed box with the oats. The use of wheat bran with oats also lessens the tendency toward choking. Oats may form the entire grain ration for horses. The substitution of 2 or 3 pounds of wheat bran improves the daily ration provided it does not produce a too laxative effect.

Corn.—In many sections corn is given preference over oats as a horse feed, as it is generally grown on the average farm or may be obtained easily. Corn may be fed on the cob, shelled, or ground. It is especially rich in carbohydrates; more energy is derived from a pound of corn than from a pound of any other suitable grain. It is considered as an economical part of a ration. Since this grain is somewhat low in protein, it is well to provide leguminous hay for the animals that are fed corn. The combination of alfalfa hay and corn is receiving much favor when fed to horses. In the absence of legumes, a little oil meal or some other protein concentrate may be included in the ration. Corn is fattening, heat producing, and is greatly relished by horses.

It is sometimes claimed that horses which are fed corn are more subject to colic than those fed oats and other grains. Little difficulty in this line, however, is experienced in the Corn Belt, where it is fed constantly. Horses that have not been accustomed to eating corn should not be changed to it suddenly; in fact, all changes in the horse ration should be made gradually. Corn is suited to form the major part of the grain ration for horses if a nitrogenous (protein) roughage is fed in combination with it.

Corn-and-cob meal.—Although the commonest practice in feeding corn to horses is to use ear or shelled corn, in occasional instances this grain is fed in the form of corn-and-cob meal. This form is especially suitable for animals which do not have the necessary time to chew thoroughly the ear or shelled corn or in case a horse's age or the condition of the teeth makes the feeding of whole grain impracticable. Corn-and-cob meal is of about the same feeding value, pound for

pound, as shelled corn, but certain precautions must be taken in feeding it. When stored for a time it has a tendency to generate heat, with the consequent formation of mold. It is therefore best to grind the grain only as needed.

Wheat.—Under ordinary conditions wheat is relatively too high in price to permit its economical use in the horse ration. If conditions permit, however, wheat may be satisfactorily used for horses provided it is crushed or rolled and fed in moderate quantities. Crushing or rolling is necessary because horses can not efficiently chew the whole, hard grains, and a limitation of the amount fed is essential to prevent digestive disturbances. Compared with corn, wheat carries slightly more carbohydrates, more crude protein, but less fat. The most satisfactory feeding results will be obtained when wheat is fed in conjunction with a bulky concentrate and when the roughage is of protein nature, rich in mineral matter, as alfalfa.

Wheat bran.—This is a favorite feed among horsemen because it is especially palatable and safe. A by-product of milling, bran is usually somewhat expensive and is not always readily available. Wheat bran is quite laxative, and for this reason it is especially valuable for pregnant mares, idle horses, and colts. With horses doing irregular work, the movement of the bowels may be regulated by increasing or decreasing the allowance of bran. Because this feed is light and soft in character it makes a good mixture with other feeds, often making them more suitable for feeding. Wheat bran is very nutritious; it is higher in protein than either oats or corn. However, it is not suited to form the entire concentrate ration for horses because it is too bulky and is somewhat deficient in lime.

Barley.—Barley is used as a principal grain for horses in many parts of the West. Except in physical character it is well suited to the horse ration. This grain should be rolled before being fed. If finely ground it will form a pasty mass with the saliva of the mouth. Barley is a little higher in total nutrients than oats, but is not so widely used nor so generally popular a feed among horsemen. Rolled barley is suitable to form the major part of the grain ration for horses.

Rye.—This may be used as a horse feed in combination with other grains. In some regions it is an economical feed. It is even higher in total nutrients than oats. The grain is small and hard and should be rolled or ground. Many horses will refuse whole rye when fed alone, and an abrupt change to rye feeding is liable to produce colic. Most of the charges against rye may be traced to the feeding of moldy or otherwise damaged grain. It is probably better to limit the amount of rye to one-third of the grain ration. It may be mixed with ground corn, bran, oats, or other grains. Rye is not generally considered desirable to form a major part of the grain ration for horses, as it is not palatable when fed alone and is liable to cause digestive disturbances.

Buckwheat.—This grain is not very commonly used as a horse feed, although it is only a little below the more common cereals in total digestible nutrients. It has a characteristic, hard, black hull which has practically no value as a feed. Unadulterated buckwheat middlings are not easily obtained. They are made from that part of the kernel just beneath the woody hull and are very rich in protein.

The common practice is to mix the middlings with the woody hulls and sell it as buckwheat feed or buckwheat bran. This product has a lower feeding value than wheat bran. If the proportion of hulls is not too large, buckwheat bran may be well used in the horse ration. Buckwheat should be limited to one-third the grain ration.

Rice.—Rice is considered economical for horse feed in some of the Southern States, the less valuable kind of rough rice being used. This grain is small and extremely hard; it should be ground or rolled before use in the horse ration. It is better to limit rough rice to one-third of the grain allowance. Rice may be used in connection with corn, blackstrap molasses, and a very limited allowance of some protein concentrate, such as cottonseed meal, soybean meal, or linseed meal.

Soybeans, cowpeas, velvet beans, horse beans, field peas.—All these are similar seeds of leguminous plants, and are suitable for use in limited amounts in the horse ration. Since all are hard seeds, they should always be ground. Their proper use in a ration for horses is as a somewhat concentrated protein feed to be combined with feeds high in carbohydrates, such as molasses and corn. Digestive troubles are very liable to occur if one or more of these feeds exceed one-third of the concentrate ration. Used with care they have a very valuable place in horse feeding.

Coconut meal.—A by-product from the manufacture of coconut oil, coconut meal is considered a safe but rather unpalatable feed for horses. It is a little higher in nutrients than wheat bran, but has the disadvantage of becoming rancid after standing a few weeks. To the extent of one-fourth of the grain ration it may replace oats where economy justifies the measure. Coconut meal is not a very heavy protein concentrate.

Peanuts.—In the form of peanut meal this feed is often given to horses. Shelled peanuts are liable to become rancid if stored for any length of time. The commercial form of peanut meal is the ground hull and kernel combined. It is a comparatively safe feed for horses, but is so rich in protein that the allowance should be limited. When it is used, animals should be started on this feed gradually and it should be fed in connection with corn or some other carbonaceous feed.

Linseed meal.—This feed is the ground cake resulting after the oil has been extracted from flaxseed. It is very high in protein, has laxative properties, but is not suited to form the bulk of the grain ration. Linseed meal is quite unpalatable, but is valuable, however, for combining with corn and other carbonaceous feeds, being a heavy protein concentrate. It is most successfully fed with ground feeds or in a mixture containing molasses, for if fed in combination with feeds from which it can be separated readily, horses will eat the palatable grains and refuse the meal. Some feeders use linseed meal as a conditioner, giving a small amount (about one-half pound) three times a week to keep the bowels in free condition. The more favorable results in the use of linseed meal are obtained when the quantity used is limited to 1 pound or less per day for each animal.

Shorts (wheat middlings).—This is not extensively used as a horse feed because it is usually high in price and its heavy nature and high protein content make it unsuitable to form the major part of the

ration. It is palatable, however, and may be used to supplement a horse ration that is low in protein. The quantity should be limited to one-fourth of the concentrate allowance.

Cottonseed meal.—The resulting ground cake after the oil has been extracted from the cottonseed is a heavy protein concentrate which, unlike linseed meal, is not laxative in character. This feed has met with considerable disfavor among horse feeders, as it is believed to have a tendency to produce digestive disorders. There is no doubt some foundation for this belief, but it has been found that the harmful results have usually followed either the use of a poor quality of meal or the feeding of too much. Cottonseed meal may be fed to horses in limited quantities if due care is exercised in obtaining bright, choice meal and if the animals are put on the diet gradually. Its proper use is as a supplement to a carbonaceous concentrate, such as corn. Favorable results have been obtained in some parts of the South in the feeding of cottonseed meal in connection with blackstrap molasses and grain. Since the meal is not palatable, it should be well incorporated with other feeds. While cottonseed meal has been fed in large quantities in isolated cases, the best results may be obtained by limiting the amount to 1 pound daily per 1,000 pounds live weight, and giving special attention to the horses being fed.[3]

Alfalfa meal.—Chopped alfalfa is often desirable to improve the physical character of a ration, but feeding alfalfa as a meal is not to be generally recommended. Alfalfa is a very valuable horse feed but is properly classed among the roughages, even though it is higher in nutrients than some of the concentrates. Finely ground alfalfa is dusty and must be dampened before it can be fed with satisfaction. There is no advantage which justifies the additional cost of grinding, except for horses with bad teeth or weak digestive organs.

Millet, kafir, and milo seeds.—These are very small, hard grains which must be ground before they are suitable for the horse ration. They compare favorably with oats in regard to total nutrients, and any of them, when ground or rolled, may be used in combination with other grains, but it is well to limit the amount used to one-third the total concentrate allowance. The sorghum grains are high in carbohydrates and tend to cause constipation when fed heavily. These grains, therefore, should be fed in conjunction with a laxative protein feed, such as wheat bran, to counteract this tendency.

Dried brewers' or distillers' grains.—These grains, which are by-products of fermentation industries, are rather heavy protein concentrates and suitable for balancing carbonaceous rations or for incorporation with chopped mixtures, but are not suitable for use as the major part of the grain ration. They are not palatable and should be limited in amount to about one-fourth the total allowance of concentrates. Some feeders claim that these feeds have a tendency to cause constipation.

Gluten meal.—A by-product of starch manufacture, it is high in protein and fairly high in carbohydrates. It is classed as a protein concentrate, and should be limited to about one-fourth the total grain allowance. It is not very palatable, but sometimes is valuable for use in chopped mixtures.

[3] For further information on the use of cottonseed meal as a horse feed, refer to U. S. Department of Agriculture Bulletin 929, "Cottonseed Meal for Horses."

Gluten feed.—This is also a protein concentrate but is somewhat less nutritious than gluten meal. Gluten feed is made by mixing corn bran with gluten meal, and is not very palatable. The proper use of gluten feed is for balancing more carbonaceous rations, and it should be limited in amount to one-third of the grain ration. Like gluten meal, it may well be used with other grains in a chopped mixture and fed with molasses.

Dried beet pulp.—A by-product of sugar manufacture, this pulp is unpalatable, but by mixing with molasses or other well-liked feeds, it may be included in the ration. It is very low in protein. Dried beet pulp is a safe feed, but it is not desirable to use it in excess of about 5 pounds in the daily ration, and it should be fed in connection with some feed that is relatively high in protein.

Cane molasses (blackstrap molasses).—The use of this feed is quite popular in cane-growing sections. It is high in carbohydrates and should be fed in connection with feeds relatively high in protein. Molasses is especially palatable and is well suited for combination with chopped mixtures containing nutritious but unpalatable feeds. It is usually desirable to dilute it with two parts of water before feeding over grain or roughage. The amount of molasses in the ration should be limited. Usually about 5 pounds daily is a very reasonable allowance, although some feeders use considerably more than that amount. Cane molasses is neither laxative nor binding in effect. Molasses is not usually an economical feed except in sugar-producing regions. However, it is often desirable to use a small amount, such as a quart (3 pounds) a day, as an appetizer.

Beet molasses.—As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain constituents stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate ration that also includes a protein feed.

Milk.—Sometimes milk may be used with good results for feeding horses. Its particular advantage is in its use for colts and for horses that are out of condition. Milk may also be a valuable feed for horses doing very light work. It is palatable, easy to digest, and valuable for fattening. If cow's milk is to be substituted for mare's milk for young colts, there should be an addition of a little sugar and a little limewater. It is not desirable to feed a large quantity of milk to horses generally, but 3 or 4 gallons a day can well be allowed a horse not doing heavy work. Milk is a safe feed, and even in clabbered condition it is not harmful.

Tankage and blood meal.—These by-products of slaughterhouses do not rank high as horse feeds. They are very high in protein, but are extremely unpalatable. They may be used, however, in amounts not exceeding 1 pound each day per animal in connection with some palatable carbonaceous mixture. Tankage and blood meal are used principally for young stock and for building up animals in extremely poor condition.

ROUGHAGES

Alfalfa hay.—This roughage is receiving very great favor as a horse feed. It contains nearly as much nutriment, pound for pound, as wheat bran. It is very high in protein and minerals; hence it is especially valuable for young stock. Alfalfa is somewhat laxative in effect. Because of this and its high protein content, it is well to limit the amount to one-half or two-thirds the roughage allowance. Timothy hay may be used to make up the rest of the roughage supply. Alfalfa is especially suited for use with a grain ration that is low in protein. Corn as the grain, and alfalfa as the roughage, equal weights of each, very nearly make a balanced ration. In considering a roughage for horses, it is desirable to furnish one that is relatively high in nutriment, since the horse has a comparatively small stomach and is unsuited to take care of great quantities of nonnutritious material. Alfalfa meets this requirement. Because of its soft stems this roughage is often used in chopped mixtures.

Timothy hay.—This hay is highly recommended for horses. Notwithstanding the fact that it is not very high in nutrients, there is probably no other one form of roughage that is better suited for the horse ration. It is low in protein and is suitable for combination with alfalfa, clover, or some other legume. If timothy is fed as the only form of roughage, the concentrate allowance should be relatively high in protein. Because of its sharp, brittle stems it is not well suited for use in chopped mixtures. It is readily available in most sections of the country. Timothy hay and oats have long been regarded as the standard horse feeds, but the combination can be improved by including some feed that is relatively high in protein.

Clover hay.—This is a good feed for horses. The usual criticism of this hay is that it is often dusty. Dampening at the time of feeding will aid somewhat, but proper care in the curing of the hay is the best means of preventing dust. Bright clover hay that is free from dust is almost as valuable as alfalfa. It is more palatable than timothy, and a mixture of clover and timothy is to be preferred to timothy alone as a roughage for horses. Clover is a legume, high in protein, somewhat laxative in effect, is an excellent feed for colts, and is suited for use in connection with a grain ration that is rather low in protein. Where only one kind of hay is fed, a smaller quantity is required of clover than of timothy. Various kinds of clovers are used for hay in different parts of the country. Common red clover is most widely used. Mammoth or Big English clover is acceptable, but is somewhat coarse. The very coarse, large varieties, such as sweet clover, are usually too woody to be very desirable. Alsike is very good, but the yield of this crop is usually not large enough to encourage its growth in most localities. If hay from crimson clover is to be used as a horse feed, the crop should be cut before the blossoms are ripe, as the hairy growth on the head of the plant becomes wiry and indigestible and forms masses similar to hair balls, in the digestive tract, which often result in serious cases of impaction. Bur clover of the South may be used as a hay for horses, but its use is not common.

Corn stover.—Corn fodder from which the grain has been removed is a common feed for horses. The objections to it are that it is usually so carelessly handled that most of the nourishment is lost, and

that the feed is allowed to become partly spoiled. It is also unhandy to feed unless some special preparation is given, and there is usually considerable waste connected with feeding it. However, corn stover that is bright and clean and which retains its leaves is very palatable, desirable, and safe for horses, and is suitable for use as the sole roughage during the fall and early winter. It is low in protein and should be fed in combination with a concentrate ration which will offset the deficiency. Cutting or shredding is usually advisable if it is to be fed in the stable.

Oat hay.—Hays from oats and similar cereals are commonly fed to horses. These crops should be cut before maturity if they are to be used as forage. They are palatable and nourishing, and care should be taken that the amount is limited. On account of the grain, the allowance should be about one-third less than would be fed in the case of the more common roughages. Very little concentrated feed is needed with oat hay, but it is desirable to include a feed relatively high in protein. Cereal hay may be fed as half the roughage allowance in connection with a legume hay. With such a combination only about half the usual grain ration is necessary.

Cowpeas, soybeans, velvet beans, and field peas.—These may be used as hay for horses. All are legumes, high in protein, and suitable for use in connection with concentrates that are high in carbohydrates, such as corn or molasses. The peas and beans are slightly laxative in effect. It is well to limit these feeds to one-half the roughage allowance; timothy or prairie hay may well be used to form the other half. The amount of grain in the pods should be taken into consideration, and the ration of concentrates should be reduced accordingly. Field-pea vines that have been carefully cured after the peas have been threshed out are fairly acceptable as horse forage. A full grain ration and a little hay should be fed with them. Unthreshed cowpeas, soybeans, velvet beans, and field peas are safe and fairly palatable feeds, but are too concentrated to form the complete roughage allowance.

Millet, or Hungarian hay.—This is suitable for use in the horse ration, provided the crop has been cut before it is too mature and that an excessive quantity is not fed. The small, hard seeds of mature millet are objectionable, as harmful action on the kidneys is claimed when an excess of these is fed. This hay is carbonaceous in character and should be fed in connection with a legume hay, or the concentrate allowance should contain feeds a little high in protein. Bright millet hay of fine growth is quite satisfactory as a horse feed when limited to half the roughage allowance.

Prairie hay.—This hay is satisfactory for use as a horse feed and is commonly used in the West. It is slightly lower in nutrients than timothy hay, is carbonaceous, and should be fed in combination with a legume hay. It is a safe feed, fairly palatable, and may form the total roughage allowance if the concentrate ration is sufficiently high in protein.

Orchard-grass hay.—Orchard grass makes a suitable hay for horses only when it is cut before maturity. It compares very favorably with timothy, and its palatability is not criticized in hay that is not too mature when cut. It is carbonaceous, and when used either the concentrates should be high in protein or a legume hay should form part of the roughage allowance. It is a safe feed for horses.

Johnson grass.—In certain sections of the South, particularly throughout the Cotton Belt States, Johnson grass grows luxuriantly, often producing three cuttings of good hay a year and forming excellent pasturage. In this district this grass may be utilized to advantage as forage for horses. Johnson grass is a carbonaceous roughage which has a feeding value equivalent to timothy, is slightly laxative in character, and is eaten with relish by horses. The principal drawback to feeding Johnson-grass hay in those sections where clean cultivation of other crops is practiced lies in the fact that such feeding distributes the seeds of the plant and makes the confinement of its growth to a limited area very difficult.

Brome grass.—This grass is of carbonaceous character and is common in the North and West. The hay is palatable and safe for horses. It is a little low in protein, and the grain ration that is fed with it should include a protein concentrate.

Straw.—Straw from various cereals, such as oats, barley, wheat, rye, and rice, is often used as a feed for horses. It is bulky, nonnutritious, and is not especially suitable, since the horse has a comparatively small stomach and its digestive anatomy is in no way suited to handle a large amount of bulky feed. So very little nourishment is derived from straw that it is not considered a suitable feed for animals doing hard work. Straw is carbonaceous, and its principal use is for idle horses. Some laxative feed should be fed in connection with it. Because of economy, it is often desirable to feed some straw, and in this case the concentrate allowance should be high in protein. A little straw may be included in a ration in which the principal roughage is alfalfa, clover, or some other legume. Oat straw is preferable; barley straw and wheat straw are good; straw from buckwheat or rye is not desirable; straw from rice is sometimes fed with good results when the remainder of the ration is high in protein. The economy of feeding straw is a factor which can not be disregarded, but the practice should not be carried to the extreme, and care should be taken to supply sufficient protein through the concentrate ration.

Vetch.—This legume is not very commonly used as a horse feed. The plant is rich in nutrients, is suitable to form about half of the roughage allowance in a ration that is lacking in protein, and is fairly palatable. A combination that is meeting with favor is vetch and oat hay.

Sudan grass.—This plant makes a suitable hay for horses and is fairly palatable. As a carbonaceous feed the hay is suitable for use as part of the roughage allowance in combination with a legume hay. Its principal use is in the South.

Bermuda grass.—Hay from this plant is sometimes used in the South. It is a carbonaceous feed, suitable for use in connection with legume hay for the roughage allowance. If fed alone the concentrate allowance should be high in protein.

Sorghum.—Fodder from sorghum may be used as dry forage for horses but does not keep for a great length of time. It is especially high in carbohydrates, is palatable and suitable for use in connection with feeds which are high in protein.

SUCCULENT FEEDS

Pasture.—Pasture is foremost among the succulent feeds for horses. It acts as a laxative and general tonic to the system, is an appetizer, and a valuable feed. Succulent feeds are watery and do not produce solid flesh. While pasture alone is sufficient to maintain idle horses, it is well to consider the relative feed value of the pasture crop and the general condition of the pasture. Usually it is advisable to feed a light grain ration relatively high in protein in connection with pasture, even when the horses are idle. Pasture is very valuable in the management of work teams; regularly allowing horses the freedom of pasture during the night and on idle days enhances the health of the animals. There will be an increased tendency toward sweating while at work but this is not of great importance when the benefits are considered. For work horses that are given pasture, other laxative feeds should be taken out of the ration. Timothy hay may be used as the roughage, and the concentrate allowances should include grains that are not laxative in character, thus making a properly balanced ration. A necessary precaution is to avoid a sudden change to green feed; where a pasture crop is included in the ration for work horses, the pasturing should be continuous, not intermittent.

Soiling crops.—Most of the forage crops previously mentioned under "Roughages" may be cut green and fed to horses. This practice is probably most common with corn. Care should be taken, however, to prevent sudden changes to this type of green feed. There is also danger of the crop's spoiling before being fed; therefore, the green feeds should be used only when fresh. The balancing in regard to nutrients should be the same for soiling crops as for pasture. The pasture system provides exercise and on this account is far preferable to soiling.

Roots.—Carrots, parsnips, rutabagas, and beets are succulent feeds used principally as an aid to digestion. Their use in the horse ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed other laxative feeds should be omitted, the roughage supply should be decreased, and the grain ration should contain feeds high in nutrients. Chopping the roots is usually advisable.

Potatoes.—Potatoes are relatively high in food value, are palatable, and are well suited for use as a horse feed where the cost is not prohibitive. It is safe to feed as high as 15 pounds a day to work horses. They are equivalent to about one-third their weight in hay. When potatoes are fed, a legume hay is a desirable supplement. If a carbonaceous hay is fed, the grain ration should contain feeds rich in protein. Potato sprouts are injurious to horses and should be removed. It is advisable to chop potatoes before feeding, as the danger from choking is thereby lessened.

Fruits.—When without stones, fruits may be used for feed and are much relished by horses. This addition to the ration is as an appetizer and relish rather than as a nutritious feed. Fruits are low in protein, and if used in considerable amount the main ration should be nitrogenous in character. Ten pounds of fruits daily are not harmful.

Pumpkins.—As a succulent feed for horses pumpkins have a fair value, their feeding value being about two-fifths that of silage, and their main use for improving digestion. The seeds have a laxative effect. It is not advisable to feed pumpkins which have been frosted. They are not usually fed in great amount and should be limited to about 8 pounds daily. No other laxative feed should be included in the same ration, there should be a slight decrease in the amount of roughage, and provision should be made for feeds relatively high in nutrients to balance the ration.

Silage.—Silage should not be considered as one of the principal roughages for horses. Its use is as a succulent, an appetizer, and tonic to be fed in limited quantities as a supplement to the regular ration. When used, this feed must be introduced gradually into the ration. It is a very dangerous practice to feed molded or frozen silage to horses. Corn silage is the only kind that has met with any degree of favor as a horse feed. It has a valuable place in the winter ration if fed with care. The amount should not exceed 10 pounds daily per animal.

WATER

There is quite a diversity of opinion among horsemen on the question of watering horses. Some feeders maintain that horses should always be watered before feeding, in order to prevent a flushing of the grain through the stomach into the small intestine. This system is not always practicable, however, as some animals will refuse to drink before eating. The consensus of opinion on watering horses indicates that water may be given either before, during, or after meals without injurious effects. Thus, individual convenience and attendant circumstances will largely determine the watering practice to be followed. In any practice, however, it is well to adhere to the same plan, once a definite watering time has been adopted, for to change frequently from one system to another will affect the animal's appetite. Regularity in watering methods as well as feeding methods should be adhered to.

The following factors should be considered in watering horses:

Horses which have been deprived of water for a long period or those which have undergone severe exertion should generally be watered before eating. It is dangerous, however, to allow an animal to drink heavily while very warm. If the horse is hot, give a moderate drink at this time, and water more freely when the animal is cool.

It is not a good practice to water heavily just before putting horses to heavy work.

Weather conditions, the nature of the work done, and the kind of feed consumed will determine the quantity of water required. In hot weather and when at hard work, horses consume more water than in cold weather or when inactive. Horses will drink more water when fed a protein-rich ration, such as alfalfa hay, than when on a carbonaceous diet.

The average water consumption per individual horse is from 10 to 12 gallons daily.

One of the times when a horse requires and appreciates a drink most is when it has finished its nightly allowance of roughage. Every horse should be allowed to drink at this time if possible.

It is better to water frequently, in small quantities, than to allow the animal to gorge itself at any one time.

Watering at public troughs is to be avoided, as this is a common method of spreading disease.

SALT

Horses should be given salt at frequent, regular intervals, or, better, salt should be accessible at all times. When salt is given regularly, only enough to meet the body requirements will be consumed, while with irregular use an abnormal appetite develops for it, which, in turn, is often followed by an excessive consumption and digestive troubles if unlimited access is allowed. An average of about three-quarters of an ounce daily should be allowed under normal conditions. Horses doing heavy work, however, or those on dry feed will consume more than this quantity.

Aside from its value as a feeding requisite, salt is of benefit as an appetizer, for in many instances delicate eaters and shy drinkers will show an increased appetite when allowed free and regular access to it.

STOCK FEEDS AND CONDIMENTS

The stock and condimental feeds that are generally bought on the market, which are represented to be conditioners, tonics, and fatteners, have for their foundation simple, well-known drugs, and feeds. If a tonic or feed is desired, one of known composition may be mixed at home with entirely satisfactory results. The following formulas are suggested:

I		II	
Glauber salt	2 pounds.	Glauber salt	5 pounds.
Soda	1 pound.	Saltpeter	1½ pounds.
Salt	1 pound.	Fenugreek	1 pound.
Fenugreek	2 ounces.	Gentian	2 pounds.
Linseed meal	25 pounds.	Linseed meal	50 pounds.

A heaping tablespoonful of one of the foregoing mixtures fed with the grain three times a day is sufficient.

When a tonic is needed it is advisable to investigate why it is needed. The horse should receive daily attention regarding feed, water, salt, exercise, grooming, sanitation, and comfortable quarters. Neglect of any of these factors is usually an underlying cause of the poor condition of an animal.

SUGGESTED DAILY RATIONS

The following daily rations have been prepared with a view of suggesting combinations of feeds that will suit conditions in various parts of the country, and from which the feeder may derive rations that will meet his local needs. Attention is invited to the fact that the rations suggested are for a horse weighing 1,000 pounds, and modification of these rations should be made for heavier or lighter horses. For example, in order to meet the requirements for a horse weighing 1,250 pounds the rations suggested should be increased in accordance with the increase in weight, which in this case is 25 per cent. Roughly this would give the feed requirement for the heavier horse.

Maintenance ration for 1,000-pound idle horse

[Theoretical daily requirement, 0.60 pound of protein and 7.30 therms of energy]

Ration	Protein	Energy
	Pounds	*Therms*
5 pounds ear corn	0.280	3.420
3 pounds alfalfa hay	.213	1.0269
9 pounds corn stover	.144	2.8458
	.637	7.2927
4 pounds oats	.348	2.7024
4 pounds clover hay	.196	1.5472
10 pounds oat straw	.08	3.481
	.624	7.7306
8 pounds alfalfa	.568	2.7384
8 pounds oat straw	.064	2.7848
3 pounds cane molasses	.000	1.6614
	.632	7.1846
5 pounds cowpea hay	.460	1.8795
5 pounds silage (corn)	.030	.7950
10 pounds timothy hay	.220	4.3020
	.710	6.9765
4 pounds rolled barley	0.332	3.5976
4 pounds alfalfa hay	.284	1.3692
7 pounds barley straw	.042	2.5627
	.658	7.5295
4 pounds alfalfa hay	.284	1.3692
14 pounds corn fodder with ears	.322	6.1516
	.606	7.5208
2 pounds shelled corn	.140	1.710
4 pounds oat hay	.156	1.290
10 pounds orchard-grass hay	.330	4.493
	.626	7.493
3½ pounds shelled corn	.245	2.9925
3 pounds cowpea hay	.276	1.127
10 pounds oat straw	.08	3.481
	.601	7.60

Daily ration for 1,000-pound horse, very light work

[Theoretical requirement, 1 pound protein and 9.80 therms energy]

Ration	Protein	Energy
	Pounds	*Therms*
10 pounds ear corn	0.56	6.840
5 pounds alfalfa hay	.355	1.711
5 pounds timothy hay	.110	2.151
	1.025	10.702
8 pounds oats	.696	5.4048
4 pounds alfalfa hay	.284	1.3692
6 pounds timothy hay	.132	2.5812
	1.112	9.3552
5 pounds cowpeas (coarsely ground)	.845	3.9730
5 pounds molasses	.000	2.7690
10 pounds oat straw	.080	3.481
	.925	10.223
8 pounds rolled barley	.664	7.1952
4 pounds alfalfa	.284	1.3692
5 pounds prairie hay	.145	2.021
	1.093	10.5854
5 pounds shelled corn	0.35	4.275
2 pounds cowpeas	.338	1.5892
½ pound cottonseed meal [1]	.177	.4672
5 pounds corn stover	.08	1.581
5 pounds sorghum fodder	.075	1.610
	1.02	9.5225
7 pounds shelled corn	.490	5.985
1 pound cottonseed meal	.354	.9346
4 pounds cowpea hay	.368	1.5036
6 pounds corn stover	.096	1.8972
	1.308	10.3204
8 pounds shelled corn	.560	6.840
4 pounds cowpea hay	.368	1.5036
6 pounds corn stover	.096	1.8972
	1.024	10.2408

[1] The meal may be replaced by 1 pound of cowpeas.

Daily ration for 1,000-pound horse at medium work

[Theoretical requirement, 1.40 pounds protein and 12.40 therms energy]

Ration	Protein	Energy	Ration	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
13 pounds ear corn	0.728	8.892	11 pounds shelled corn	0.770	9.405
6 pounds alfalfa hay	.426	2.0538	6 pounds cowpea hay	.552	2.2554
7 pounds timothy hay	.154	3.0114	6 pounds corn stover	.096	1.8972
	1.308	13.9572		1.418	13.557
12 pounds oats	1.044	8.1072	5 pounds cowpea hay	.460	1.8795
1 pound cowpeas (cracked)	.169	.7946	9 pounds corn stover	.144	2.8458
11 pounds timothy	.242	4.7322	10 pounds shelled corn	.700	8.550
	1.455	13.6340	½ pound cottonseed meal	.177	.4673
				1.48	13.7426
10 pounds rolled barley	.83	8.9940			
6 pounds alfalfa hay	.426	2.0538			
5 pounds prairie hay	.165	2.021			
	1.421	13.0688			

Daily ration for 1,000-pound horse at severe work

[Theoretical requirement, 2 pounds protein and 16 therms energy]

Ration	Protein	Energy	Ration	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
12 pounds oats	1.044	8.1072	10 pounds rolled barley	0.830	8.9940
2 pounds bran	.216	1.0600	2 pounds gluten meal	.562	1.6830
8 pounds timothy hay	.176	3.4416	8 pounds alfalfa	.568	2.7384
5 pounds clover hay	.245	1.9340	6 pounds prairie hay	.174	2.4252
	1.681	14.5428		2.134	15.8406
12 pounds shelled corn	.840	10.260	5 pounds cowpea hay	.460	1.8795
1 pound soybeans (ground)	.273	.8129	9 pounds corn stover	.144	2.8458
12 pounds alfalfa	.852	4.1076	13 pounds shelled corn	.910	11.115
4 pounds corn stover	.084	1.2648	1½ pounds cottonseed meal	.531	1.4019
	2.049	16.4453		2.045	17.2422
7 pounds peanuts (ground with hull)	1.183	5.8205			
7 pounds cane molasses	.000	3.8766			
7 pounds pea hay	.644	2.6313			
7 pounds timothy hay	.154	3.0114			
	1.981	15.3428			

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UNITED STATES DEPARTMENT OF AGRICULTURE

September 22, 1924

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This bulletin is a contribution from

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FARMERS' BULLETIN No. 1030 Rev.
June 1927

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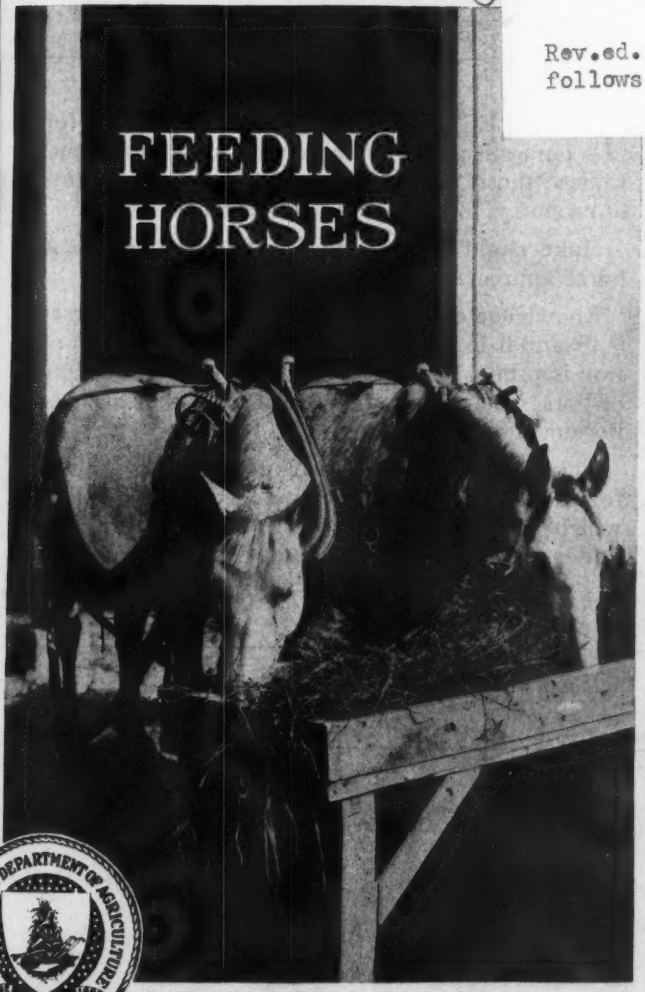
FEEDING HORSES



THE SELECTION of the most suitable ration for horses is governed largely by local conditions. Choose those feeds which meet the requirements of economy, nutrition, and convenience.

Make slight changes in feeds occasionally. A horse appreciates a variety in his diet.

Knowledge of individual requirements of horses is essential to obtain best results. Close observation is probably a more vital factor in the feeding of horses than in the feeding of any other class of livestock.

This bulletin explains the computation of rations for horses, suggests certain feed combinations which approximately meet the needs of horses under varying conditions, and reviews such factors of feeding as tend to make the horse more efficient.

Washington, D. C. Issued December, 1916;
Revised April, 1926, and June, 1927

FEEDING HORSES

By G. A. BELL, formerly *Senior Animal Husbandman*,[1] and J. O. WILLIAMS, *Senior Animal Husbandman in Horse and Mule Investigations, Animal Husbandry Division, Bureau of Animal Industry*

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STUDY OF RATIONS NECESSARY

The computation of rations is valuable as a guide to the feeder in determining approximate rations from a large variety of feeds. It is useful, also, in determining the requisite amount of nutrients, so that each will be supplied without waste. Results in feeding a ration should be observed and the ration modified according to the age, size, and condition of the horse. The amount and kind of work performed will determine the kind and quantity of feed to use.

There is far more economy in supplying the required amounts of nutrients in the right proportions than in providing an excess of one and a deficiency of another. Proper attention given to the matter of balancing horse rations will result in benefit to both the health and the working efficiency of the animals fed, which in turn will effect a material reduction in the enormous annual feed bill charged against the horses of the country.

LOCAL INFLUENCES IMPORTANT

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, combinations of home-grown or locally raised crops constitute the most economical rations. Choose from the feeds available those which will most closely meet the requirements of economy, nutrition, and convenience. Substitution may often be made in rations in such a manner that, while the efficiency remains unchanged, the cost is materially lowered. Selection of the most economical and suitable ration is governed largely by local conditions.

CONDITIONS AFFECTING FEED REQUIREMENTS

The kinds of feed used, the quantity required per animal, and the manner of feeding depend on the age, size, and condition of the horse, the amount and kind of work done, and the individual fed.

The horse at work requires more and richer feed than the idle one. To furnish energy for work, the feed allowance must be in excess of that needed for body maintenance. The amount of feed needed for maintenance is about two-thirds that required for a horse at moderate work. If the work done calls for more energy than is furnished in the ration, the stored-up energy of the body fat or other tissues will be drawn on, with a consequent loss in body weight and energy. If such feeding practice is continued, the horse will be so weakened constitutionally that he will be unable to perform his work profitably

[1] Mr. Bell resigned from the department Oct. 15, 1920.

and also will be especially susceptible to disease.

Horses of the same type and weight may have different feed requirements, which makes it necessary to study the individuality of the animals. If the horse is not doing well on a ration, a slight change should be made. Any change, however, should be made gradually in order to avoid digestive disturbances.

SELECTING A RATION

As no feed or combination of feeds will meet conditions in all parts of the country, so no feed or mixture of feeds is suitable for all classes of horses. In choosing a ration for a horse, select the one that seems to meet best his requirements, whether for growth, maintenance, work, breeding, or fattening; estimate the amount of feed needed, and try out the ration. It may appear after a trial that too little is being fed or that the ration may be changed somewhat in the interest of either economy or efficiency. If a number of horses are kept, different rations may be tested on different animals and the best one selected for general use. Individual feeding gives the best results.

PREPARATION OF FEEDS

The advisability of chopping, cutting, or chaffing hay for horse feeding depends largely on the cost of preparation, the quality of the feed, and its price. Ordinarily, low-priced hay of good quality should not be prepared for feeding, but it may be economical to chop, cut, or chaff poor-quality hay, as it is eaten with less waste than the unprepared forage.

Such roughages as corn stover and sorghum can generally be fed to horses most satisfactorily when shredded or cut. Preparation makes the feed much easier to handle in the stable and results in a greater proportionate consumption of the roughage.

The benefits derived from grinding or crushing oats and corn for horses depend on the cost of preparation, working conditions, and the condition of the animals' teeth. Throughout the Corn Belt corn is usually fed on the cob or in the shelled form, and it ordinarily does not pay to grind it for horses unless the animals' teeth are in poor condition or if there is not time enough for proper mastication of the grain. All small, hard grains, such as rye, barley, and wheat, should be crushed or rolled before feeding, to avoid digestive disturbances, since horses can not properly masticate those grains.

Ordinarily it is not advisable to cook, steam, or soak feeds for horses, since those methods of preparation do not materially improve digestion. When, however, the small, hard grains can not be rolled or crushed, it is a good plan to soak them. It is the accepted practice, moreover, of many horsemen to feed a warm mash occasionally as a tonic and to regulate the bowels.

BALANCING A RATION

Feeding stuffs are broadly divided into two general classes, protein and carbohydrate. The protein feeds are rich in nitrogenous compounds which are used by the animal body in building tissue, bone, hair, etc., and to provide energy. The carbohydrate feeds are starchy in nature and are used by the animal body in the formation of fat and for energy and heat.

To obtain the best results in feeding, the ration should be so balanced that it properly meets the needs of the animal in building tissue and in supplying energy for work. In order to do this, feeds containing the nutrients which supply the required proteins and energy are needed in certain proportions to meet the body requirements. If feeds deficient in protein are fed an excessive amount of carbonaceous nutrients must be consumed in order that the system may obtain the required quantity of protein, and vice versa, and so a waste of feed will be the result. It is essential, therefore, that a balanced ration be fed, that is, one containing proteins and carbohydrates in such proportions that the requisite amounts of each will be utilized without waste.

Feeds rich in protein are usually the most expensive. If more protein is supplied than is needed for nutrition, the cost of the feed is unnecessarily increased. It is more economical to supply the energy necessary to perform work in the form of carbohydrates than proteins. Thus for mature horses at work and for maintaining idle horses the protein feed allowance may be limited to the amount necessary to build tissue, and a large proportion of carbohydrates may be fed.

FEEDING HINTS

The grain part of the ration for horses at work is usually divided into three equal feeds. If the horse does

not clean up grain in a reasonable length of time, the quantity should be reduced. About two-thirds of the daily hay allowance is given at night, with most of the remainder fed in the morning, leaving only a very small allowance for the noon feed. The quantity of roughage should be limited within the maximum allowance, so that all the edible forage will be cleaned up every day. When there is forage remaining from the night feeding, do not put in a fresh supply, but stir up that which is in the manger, so that the chaff goes to the bottom, leaving the good hay available. Some hay should be fed before the grain at night, for the appetite of the horse is not appeased by the grain when it is fed first, and it fills up on hay, forcing the grain on through the stomach too quickly, thereby decreasing the quantity assimilated.

The method of feeding has a great deal to do with the utilization of the feed and the condition of the horse. It is important that the horse that bolts grain be made to eat slowly, which may be done by feeding the grain spread out in a large, flat box, by placing several smooth stones about 3 inches in diameter in the feed box, or by mixing it with bran, cut hay, or similar feed. Some horses waste their hay by pulling it out and trampling it under foot. This is sometimes caused by feeding two kinds of hay, one of which is especially palatable. In that case, the waste may be corrected by feeding the hay so that the horse can eat the more palatable first. The horse will then eat the other hay leisurely during the night. Another plan is to withhold the good hay until the other is eaten.

Overfeeding, rather than underfeeding, is the common practice when horses are working irregularly. It should be remembered that the amount of feed should vary, not only between winter and summer but also from day to day. It is a waste of feed if the amount is not varied with the degree of work.

FEEDING IDLE HORSES

Maintaining the farm work horse in healthful condition during the winter is the first start in fitting it for spring work. The horse should not be so fed during the winter that it becomes fat and soft. Moreover it is bad management to let a horse lose weight during the winter and then try to bring it back to normal by heavy feeding just before the beginning of spring work.

The liberal use of roughage, supplemented with the right quantity and kind of other nutritious feed, will maintain a horse properly during the winter. Farm horses, except brood mares or growing stock, do well on a ration made up largely of the coarser hays, straw, or corn fodder. Cornstalk fields, grain-stubble fields, or pastures which have not been closely grazed during the summer are very desirable sources of a large part of the winter maintenance feed. The common roughages, as the main part of the ration during this period, will supply bulky feed enough to keep the horse thrifty without putting on superfluous fat. The drinking of a large quantity of pure water should be encouraged to increase the utilization of these dry roughages. When necessary, a tank heater should be used to keep the drinking trough free from ice.

It is advisable to supplement the coarser roughages with a legume, such as alfalfa, clover, vetch, soy-bean, or cowpea hay. These hays are very palatable and should be fed sparingly. They are rich in protein and mineral matter and supply the materials needed to replace those lost in the natural wear of the body. Being somewhat laxative in effect they also help to keep the digestive tract in good condition. They are especially valuable in connection with straw and similar feed. The use of these hays with the coarser roughages is economical because a supplemental ration of grain is not necessary.

In some instances, especially when it is not possible to feed a legume hay, a small quantity of grain is necessary to maintain the horses in thrifty condition. Oats are preferred for use with coarser roughages, but corn and barley are often used in the winter ration, especially when they are cheaper or when an increase in weight is desired. One or two bran mashes a week or a little linseed meal each day is recommended as an aid in keeping the system in good condition and in preventing impaction resulting from the use of large quantities of coarse roughage improperly supplemented.

Pregnant mares require more attention during the winter than the open mare or gelding. Leguminous feeds high in protein and ash are necessary in developing the fetus. Although the feeding of the legume hay is of more importance than a supplemental grain feed, in most cases such feeds as oats, bran, and oil meal should be supplied, the proportions being largely controlled

by the condition of the mare and the stage of development of the fetus.

THE COMPUTATION OF RATIONS[2]

The computation of rations is not difficult, and a little time spent on calculations enables the feeder to provide, from available feeds, a ration which will approximately supply the requisite amounts of protein and carbohydrates. Data on rations will afford valuable aid to the feeder, but he must observe results and modify his feeding accordingly.

The rations given in this publication are based on the true protein and the net energy values of various feeding stuffs. The net energy value is the measure of the true value of the feed as a source of energy to the animal organism after deducting the losses in the unburned materials in the excreta and the energy expended in extracting the real fuel materials from the feed consumed. For example, while 100 pounds of corn meal contain about 187 therms of chemical energy, only about 85 therms remain, after the above-mentioned deductions have been made, to represent the actual value of the meal as a source of energy to the animal.

The following table is adapted from a similar one published in Department Bulletin 459, and gives the true protein and net energy values per 100 pounds of feeding stuffs for ruminants. It may be regarded as expressing with sufficient accuracy the relative value of feeding stuffs for horses. A column has been added designating the group in which some of the common feeds are ordinarily classified. This is done in order to simplify the selection of feeds for compounding a ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DRIED ROUGHAGE				
Hay and fodder from cereals		*Pounds*	*Pounds*	*Therms*
Brome grass, smooth	Carbohydrate	91.5	3.5	40.83
Corn (maize) fodder (ears included, medium dry)	do	81.7	2.3	43.94
Corn (maize) stover (ears removed, medium dry)	do	81.0	1.6	31.62
Kafir fodder, high in water	do	71.7	1.8	34.28
Kafir stover, high in water	do	72.7	1.0	27.65
Millet, Hungarian	do	85.7	3.9	46.96
Timothy and clover mixed		87.8	3.6	40.85
Oat hay	Carbohydrate	88.0	3.9	32.25
Orchard grass	do	88.4	3.3	44.93
Prairie hay	do	93.5	2.9	40.42
Red top	do	90.2	3.9	51.22
Sorghum fodder, computed to 80 per cent dry matter	do	80.0	1.5	32.30
Timothy, all analyses	do	88.4	2.2	43.02
Hay and fodder from legumes				
Alfalfa, all analyses	Protein	91.4	7.1	34.23
Clover, alsike	do	87.7	5.3	34.42
Clover, crimson	do	89.4	6.9	36.21
Clover, red, all analyses	do	87.1	4.9	38.68
Clover, sweet white	do	91.4	6.7	39.98
Cowpeas, all analyses	do	90.3	9.2	37.59
Soy beans	do	91.4	8.8	44.05
Straws				
Barley	Carbohydrate	85.8	.6	36.61
Buckwheat	do	90.1	3.2	4.55
Oat	do	88.5	.8	34.81
Rice	do	92.5	.4	23.63
Rye	do	92.9	.5	17.59
Wheat	do	91.6	.3	7.22

[2] For detailed information relative to the computation of rations, consult U. S. Department of Agriculture Bulletin 459, "The Use of Energy Values in the Computation of Rations for Farm Animals," by Henry Prentiss Armsby.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
FRESH GREEN ROUGHAGE				
Green cereals, etc.		*Pounds*	*Pounds*	*Therms*
Barley fodder		23.2	2.0	14.06
Bluegrass, Kentucky, before heading		23.8	2.8	14.82
Bluegrass, Kentucky, headed out		36.4	2.2	17.77
Bluegrass, Kentucky, after bloom		43.6	1.6	21.01
Buckwheat, Japanese		36.6	1.5	17.78
Cabbage		8.9	1.3	8.87
Corn (maize) fodder, dent, all analyses		23.1	.8	14.60
Corn (maize) fodder, flint, all analyses		20.7	.8	13.53
Corn (maize) fodder, sweet, roasting ears or later		20.3	.9	13.38
Corn (maize) fodder, sweet, ears removed		21.5	.8	14.26
Millet, Hungarian		27.6	1.1	17.24
Oat fodder		26.1	2.0	14.06
Orchard grass		29.2	1.1	15.81
Rape		16.7	1.7	13.07
Rye fodder		21.3	1.4	15.99
Sorgo fodder		24.9	.4	15.37
Timothy, before bloom		24.2	1.1	18.36
Timothy, in bloom		32.1	.8	18.89
Timothy, in seed		46.4	1.0	26.36
Wheat fodder		27.4	1.9	18.75
Green legumes [1]				
Alfalfa, before bloom		19.9	1.9	9.20
Alfalfa, in bloom		25.9	1.8	11.50
Alfalfa, after bloom		29.8	1.3	11.10
Clover, alsike		24.3	1.5	14.56
Clover, crimson		17.4	1.6	10.83
Clover, red, all analyses		26.2	1.7	15.87
Clover, red, in bloom		27.5	1.8	16.74
Clover, red, rowen		34.4	2.2	17.30
Cowpeas		16.3	1.7	10.42
Peas, Canada field		16.6	2.1	9.78
Soy beans, all analyses		23.6	2.4	12.53
Vetch, hairy		18.1	2.4	11.95
SILAGE [1]				
Corn (maize), well-matured, recent analysis		26.3	.6	15.90
Corn (maize), immature		21.0	.4	11.96
Corn (maize), from field-cured stover		19.6	.3	8.98
Clover		27.8	.8	7.26
Cowpeas		22.0	1.1	11.05
Soy beans		27.1	1.5	11.59
Sugar-beet pulp		10.0	.5	9.32
ROOTS, TUBERS, AND FRUITS [1]				
Apples		18.2	.1	15.92
Beets, common		13.0	.1	7.84
Beets, sugar		16.4	.4	11.20
Carrots		11.7	.5	9.21
Mangels		9.4	.1	5.68
Potatoes		21.2	.1	18.27
Pumpkins, field		8.3	.6	6.05
Rutabagas		10.9	.3	8.46
Turnips		9.5	.4	6.16
GRAINS				
Cereal grains				
Barley	Protein	90.7	8.3	89.94
Buckwheat	do	87.9	7.2	59.73
Corn (maize), dent	Carbohydrate	89.5	7.0	85.50
Corn (maize), flint	do	87.8	7.2	84.00
Corn (maize) and cob meal	do	89.6	5.7	75.80
Corn (maize) meal	do	88.7	6.4	85.20
Oats	Protein	90.8	8.7	67.56
Oatmeal	do	92.1	11.5	86.20
Rice, rough	Carbohydrate	90.4	4.5	77.33
Rye	Protein	90.6	9.0	93.71
Sorghum grain	Carbohydrate	87.3	6.7	89.75
Wheat, winter	Protein	89.1	7.7	91.66
Wheat, spring	do	89.9	8.1	91.41

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
GRAINS—continued				
Leguminous seeds		*Pounds*	*Pounds*	*Therms*
Beans, navy	Protein	86.6	16.4	73.29
Cowpeas	do	88.4	16.9	79.46
Peas, field	do	90.8	16.6	78.72
Pea meal	do	89.1	17.2	77.62
Peanuts with hull	do	93.5	16.9	83.15
Peanut kernel	do	94.0	22.2	109.04
Soy beans	do	90.1	27.3	81.29
Oil seeds				
Cottonseed	Protein	90.6	11.9	78.33
Flaxseed	do	90.8	19.2	83.17
Sunflower seed	do	95.5	20.2	95.77
Sunflower seed with hulls	do	93.1	11.7	92.49
DAIRY PRODUCTS				
Buttermilk	Protein	9.4	3.4	13.32
Cow's milk	do	13.6	3.3	29.01
Skim milk—centrifugal	do	9.9	3.6	14.31
Skim milk—gravity	do	9.6	3.1	15.43
Skim milk—dried	do	91.7	34.4	103.91
Whey	Carbohydrate	6.6	.8	10.39
Milling				
Buckwheat bran	Protein	88.8	9.1	30.59
Buckwheat hulls	Carbohydrate	89.7		−7.69
Buckwheat middlings	Protein	88.0	20.8	72.19
Hominy feed	Carbohydrate	89.9	6.5	88.78
Red-dog flour	Protein	88.9	13.2	78.80
Rice bran, high-grade	Carbohydrate	89.9	7.0	45.29
Rice meal	do	90.5	6.4	65.24
Rice polish	do	90.0	7.1	77.70
Rye bran	Protein	88.6	10.5	79.35
Wheat bran	do	89.9	10.8	53.00
Wheat middlings, flour	do	89.3	14.0	75.02
Wheat middlings, standard	do	89.6	12.0	59.10
Oil extraction				
Coconut meal, low in fat	Protein	90.4	18.3	83.49
Coconut meal, high in fat	do	92.3	18.0	100.31
Cottonseed hulls	Carbohydrate	90.3		9.92
Cottonseed meal, choice	Protein	92.5	35.4	93.46
Cottonseed meal, prime	do	92.2	32.0	90.00
Linseed meal, new process	do	90.4	30.9	85.12
Linseed meal, old process	do	90.9	28.5	88.91
Peanut cake from hulled nuts	do	89.3	41.4	93.55
Peanut cake, hulls included	do	94.4	19.5	42.57
Soy-bean meal, fat extracted	do	88.2	37.3	99.65
Sunflower-seed cake	do	90.0	29.1	88.87
Starch manufacturing				
Gluten feed	Protein	91.3	20.1	80.72
Gluten meal	do	90.9	28.1	84.15
Starch feed, dry	Carbohydrate	90.9	9.2	77.46
Starch feed, wet	do	33.4	3.7	30.45
Sugar manufacture				
Molasses, beet	Protein	74.7		57.10
Molasses, cane or blackstrap	do	74.2		55.38
Molasses beet pulp	do	92.4	3.5	76.28
Sugar-beet pulp, dried	do	91.8	.7	75.87
Sugar-beet pulp, ensiled	do	10.0	.5	9.32
Sugar-beet pulp, wet	do	9.3	.5	8.99
Packing house				
Dried blood	Protein	90.3	68.6	68.13
Tankage:				
Over 60 per cent protein	do	92.6	55.6	93.04
55–60 per cent protein	do	92.5	51.1	83.39
45–55 per cent protein	do	92.5	45.5	72.96
Below 45 per cent protein	do	93.5	35.6	54.10

REQUIREMENTS FOR WORK

Rations containing the following amounts of digestible protein and of net energy value may be used as a guide in computing daily rations for the 1,000-pound work horse under varying conditions:

Kind of work	Digestible protein	Net energy value
	Pounds	*Therms*
For light work	1.0	9.80
For medium work	1.4	12.40
For heavy work	2.0	16.00

(Dry matter: For the 1,000-pound horse, from 16 to 25 pounds is a fair average, depending on the amount of work performed.)

METHOD OF COMPUTING RATIONS

Following is an example in computing a ration that will meet approximately the needs of a 1,000-pound horse or mule at medium work:

From the table above we know the requirement to be 1.4 pounds digestible protein and 12.4 therms of energy. A reasonable estimate for grain is that about $1\frac{1}{9}$ pounds per 100 pounds live weight is required, which would make a total of 11 pounds of grain daily for a 1,000-pound horse. A reasonable estimate for the amount of roughage is $1\frac{1}{9}$ pounds per 100 pounds live weight, which makes the requirement about 12 pounds of hay daily.

The next step is to list the available feeds; in this case let us assume that shelled corn, oats, alfalfa, and timothy hay are available.

From the list of analyses in the first table we know the composition of each of these feeds. The desired object is to combine the feeds so that the total nutrients will be 1.4 pounds digestible protein and 12.4 therms of energy. The estimated amounts of grain and roughage are merely guides.

We first make a rough estimate of the amount of each feed necessary; then calculate the actual nutriment in the estimated amounts; and, lastly, make reductions, additions, or substitutions to the ration so that the total amount of nutrients will be very near 1.4 pounds of protein and 12.4 therms of energy.

For a trial ration let us take 7 pounds of oats and 4 pounds of corn for concentrates and 6 pounds each of alfalfa hay and timothy hay for roughages. According to the analyses, 100 pounds of oats have 8.7 pounds of true protein and 67.56 therms of energy. In our trial ration we are using 7 pounds of oats, which is $\frac{7}{100}$ of 100 pounds. Multiplying 8.7 and 67.56 by $\frac{7}{100}$, we find that in 7 pounds of oats there are 0.609 of a pound of protein and 4.7292 therms of energy. By similar use of the table we can determine the nutrients in the other feeds used in the estimated ration as follows:

Trial ration for 1,000-pound horse or mule at medium work

Ration	True protein	Energy
	Pounds	*Therms*
7 pounds oats	0.609	4.7292
4 pounds corn	.280	3.4200
6 pounds alfalfa hay	.426	2.0538
6 pounds timothy hay	.132	2.5812
Total	1.447	12.7842
Theoretical requirement	1.4	12.4

The computed ration is satisfactory in filling the theoretical requirements and has a slight margin of surplus. This is close enough for practical purposes.

If, in computing the nutrients in an estimated ration, the amount of protein is found to be low and the amount of net energy is high, there should be substituted a feed comparatively high in protein and low in energy; thus alfalfa hay sometimes may be substituted for timothy, or wheat bran may replace part of the corn in a ration.

It is not satisfactory to depend wholly upon grains and other concentrated feeds for furnishing nutrients to horses; neither will it do to provide only roughage. The horse has a relatively small stomach and can not take care of great quantities of coarse, nonnutritious feed, but there must be sufficient bulk to the ration to make normal the process of digestion. Both concentrates and roughages are necessary.

FEED FOR LIGHT HORSES

In horses of the light breeds that are used for pleasure or racing, the qualities desired are spirit, action, and endurance, and large, paunchy stomachs are objectionable. Such horses require proportionately more grain and less hay than horses doing slow or heavy work. Oats easily rank first among the feeds for light horses; they

may be supplemented with crushed or soaked barley and bran. Corn is too fattening to constitute the bulk of the concentrates for light horses; it may be used, however, if supplemented with linseed meal or bran. A mixture of one of the legume hays, as alfalfa or clover, fed with timothy or other hay, will furnish the roughage. A larger quantity of hay should be allowed for horses less actively employed and should be fed mostly at night. One pound of hay and 1 to 1¼ pounds of grain per 100 pounds live weight will be sufficient for such light horses at moderate work.

FEEDING WORK HORSES

The quantity of feed for the work horse depends on the amount of work done and on the speed at which it is performed; a horse requires considerably more feed when working at the trot than at the walk. As before stated, it is a good rule to allow 1⅙ pounds of grain and 1⅓ pounds of hay per 100 pounds live weight for horses at moderate work. At this rate a 1,200-pound horse would require 13 pounds of grain and about 14½ pounds of hay per day. If the work is severe, the quantity of grain should be increased. The horse at hard work requires 1¼ to 1⅓ pounds of grain per 100 pounds live weight; the hay fed, however, should not be over 1¼ pounds per 100 pounds live weight. The exact quantity will depend largely on the individuality of each horse.

PRINCIPAL FEEDS FOR HORSES

In connection with rations for horses a brief discussion of the merits of the more common feeds will assist in the choice of a ration. The nutrients contained in each feed may be ascertained by consulting the table of analyses. It is the special purpose of the following review to judge the feeds from the standpoint of the horse feeder.

For convenience the feeds will be classified as concentrates, roughages, succulent feeds, and condiments.

CONCENTRATES

Oats.—This grain ranks as one of the very best for horses. The kernel is incased in a hull which, although it has no great nutritive value, greatly improves the physical character of the feed by adding bulk. Oats probably come nearer to filling the requirements of a concentrate for horses than any other grain. Compared with corn, oats have more protein and less carbohydrates. Oats are readily available in almost every part of the country and may be fed either whole or ground. They should be rolled or ground for very young animals.

Some horses eat oats too rapidly. With such ravenous feeders, to prevent the danger of choking, it is advisable to place a little chopped clover hay or some whole corncobs in the feed box with the oats. The use of wheat bran with oats also lessens the tendency toward choking. Oats may form the entire grain ration for horses. The substitution of 2 or 3 pounds of wheat bran improves the daily ration provided it does not produce a too laxative effect.

Corn.—In many sections corn is given preference over oats as a horse feed, as it is generally grown on the average farm or may be obtained easily. Corn may be fed on the cob, shelled, or ground. It is especially rich in carbohydrates; more energy is derived from a pound of corn than from a pound of any other suitable grain. It is considered as an economical part of a ration. Since this grain is somewhat low in protein, it is well to provide leguminous hay for the animals that are fed corn. The combination of alfalfa hay and corn is receiving much favor when fed to horses. In the absence of legumes, a little oil meal or some other protein concentrate may be included in the ration. Corn is fattening, heat producing, and is greatly relished by horses.

It is sometimes claimed that horses which are fed corn are more subject to colic than those fed oats and other grains. Little difficulty in this line, however, is experienced in the Corn Belt, where it is fed constantly. Horses that have not been accustomed to eating corn should not be changed to it suddenly; in fact, all changes in the horse ration should be made gradually. Corn is suited to form the major part of the grain ration for horses if a nitrogenous (protein) roughage is fed in combination with it.

Corn-and-cob meal.—Although the commonest practice in feeding corn to horses is to use ear or shelled corn, in occasional instances this grain is fed in the form of corn-and-cob meal. This form is especially suitable for

animals which do not have the necessary time to chew thoroughly the ear or shelled corn or in case a horse's age or the condition of the teeth makes the feeding of whole grain impracticable. Corn-and-cob meal is of about the same feeding value, pound for pound, as shelled corn, but certain precautions must be taken in feeding it. When stored for a time it has a tendency to generate heat, with the consequent formation of mold. It is therefore best to grind the grain only as needed.

Wheat.—Under ordinary conditions wheat is relatively too high in price to permit its economical use in the horse ration. If conditions permit, however, wheat may be satisfactorily used for horses provided it is crushed or rolled and fed in moderate quantities. Crushing or rolling is necessary because horses can not efficiently chew the whole, hard grains, and a limitation of the amount fed is essential to prevent digestive disturbances. Compared with corn, wheat carries slightly more carbohydrates, more crude protein, but less fat. The most satisfactory feeding results will be obtained when wheat is fed in conjunction with a bulky concentrate and when the roughage is of protein nature, rich in mineral matter, as alfalfa.

Wheat bran.—This is a favorite feed among horsemen because it is especially palatable and safe. A by-product of milling, bran is usually somewhat expensive and is not always readily available. Wheat bran is quite laxative, and for this reason it is especially valuable for pregnant mares, idle horses, and colts. With horses doing irregular work, the movement of the bowels may be regulated by increasing or decreasing the allowance of bran. Because this feed is light and soft in character it makes a good mixture with other feeds, often making them more suitable for feeding. Wheat bran is very nutritious; it is higher in protein than either oats or corn. However, it is not suited to form the entire concentrate ration for horses because it is too bulky and is somewhat deficient in lime.

Barley.—Barley is used as a principal grain for horses in many parts of the West. Except in physical character it is well suited to the horse ration. This grain should be rolled before being fed. If finely ground it will form a pasty mass with the saliva of the mouth. Barley is a little higher in total nutrients than oats, but is not so widely used nor so generally popular a feed among horsemen. Rolled barley is suitable to form the major part of the grain ration for horses.

Rye.—This may be used as a horse feed in combination with other grains. In some regions it is an economical feed. It is even higher in total nutrients than oats. The grain is small and hard and should be rolled or ground. Many horses will refuse whole rye when fed alone, and an abrupt change to rye feeding is liable to produce colic. Most of the charges against rye may be traced to the feeding of moldy or otherwise damaged grain. It is probably better to limit the amount of rye to one-third of the grain ration. It may be mixed with ground corn, bran, oats, or other grains. Rye is not generally considered desirable to form a major part of the grain ration for horses, as it is not palatable when fed alone and is liable to cause digestive disturbances.

Buckwheat.—This grain is not very commonly used as a horse feed, although it is only a little below the more common cereals in total digestible nutrients. It has a characteristic, hard, black hull which has practically no value as a feed. Unadulterated buckwheat middlings are not easily obtained. They are made from that part of the kernel just beneath the woody hull and are very rich in protein. The common practice is to mix the middlings with the woody hulls and sell it as buckwheat feed or buckwheat bran. This product has a lower feeding value than wheat bran. If the proportion of hulls is not too large, buckwheat bran may be well used in the horse ration. Buckwheat should be limited to one-third the grain ration.

Rice.—Rice is considered economical for horse feed in some of the Southern States, the less valuable kind of rough rice being used. This grain is small and extremely hard; it should be ground or rolled before use in the horse ration. It is better to limit rough rice to one-third of the grain allowance. Rice may be used in connection with corn, blackstrap molasses, and a very limited allowance of some protein concentrate, such as cottonseed meal, soy-bean meal, or linseed meal.

Soy beans, cowpeas, velvet beans, horse beans, field peas.—All these are similar seeds of leguminous plants, and are suitable for use in limited amounts in the horse ration. Since all are hard

seeds, they should always be ground. Their proper use in a ration for horses is as a somewhat concentrated protein feed to be combined with feeds high in carbohydrates, such as molasses and corn. Digestive troubles are very liable to occur if one or more of these feeds exceed one-third of the concentrate ration. Used with care they have a very valuable place in horse feeding.

Coconut meal.—A by-product from the manufacture of coconut oil, coconut meal is considered a safe but rather unpalatable feed for horses. It is a little higher in nutrients than wheat bran, but has the disadvantage of becoming rancid after standing a few weeks. To the extent of one-fourth of the grain ration it may replace oats where economy justifies the measure. Coconut meal is not a very heavy protein concentrate.

Peanuts.—In the form of peanut meal this feed is often given to horses. Shelled peanuts are liable to become rancid if stored for any length of time. The commercial form of peanut meal is the ground hull and kernel combined. It is a comparatively safe feed for horses, but is so rich in protein that the allowance should be limited. When it is used, animals should be started on this feed gradually and it should be fed in connection with corn or some other carbonaceous feed.

Linseed meal.—This feed is the ground cake resulting after the oil has been extracted from flaxseed. It is very high in protein, has laxative properties, but is not suited to form the bulk of the grain ration. Linseed meal is quite unpalatable, but is valuable, however, for combining with corn and other carbonaceous feeds, being a heavy protein concentrate. It is most successfully fed with ground feeds or in a mixture containing molasses, for if fed in combination with feeds from which it can be separated readily, horses will eat the palatable grains and refuse the meal. Some feeders use linseed meal as a conditioner, giving a small amount (about one-half pound) three times a week to keep the bowels in free condition. The more favorable results in the use of linseed meal are obtained when the quantity used is limited to 1 pound or less per day for each animal.

Shorts (wheat middlings).—This is not extensively used as a horse feed because it is usually high in price and its heavy nature and high protein content make it unsuitable to form the major part of the ration. It is palatable, however, and may be used to supplement a horse ration that is low in protein. The quantity should be limited to one-fourth of the concentrate allowance.

Cottonseed meal.—The resulting ground cake after the oil has been extracted from the cottonseed is a heavy protein concentrate which, unlike linseed meal, is not laxative in character. This feed has met with considerable disfavor among horse feeders, as it is believed to have a tendency to produce digestive disorders. There is no doubt some foundation for this belief, but it has been found that the harmful results have usually followed either the use of a poor quality of meal or the feeding of too much. Cottonseed meal may be fed to horses in limited quantities if due care is exercised in obtaining bright, choice meal and if the animals are put on the diet gradually. Its proper use is as a supplement to a carbonaceous concentrate, such as corn. Favorable results have been obtained in some parts of the South in the feeding of cottonseed meal in connection with blackstrap molasses and grain. Since the meal is not palatable, it should be well incorporated with other feeds. While cottonseed meal has been fed in large quantities in isolated cases, the best results may be obtained by limiting the amount to 1 pound daily per 1,000 pounds live weight, and giving special attention to the horses being fed.[8]

Alfalfa meal.—Chopped alfalfa is often desirable to improve the physical character of a ration, but feeding alfalfa as a meal is not to be generally recommended. Alfalfa is a very valuable horse feed but is properly classed among the roughages, even though it is higher in nutrients than some of the concentrates. Finely ground alfalfa is dusty and must be dampened before it can be fed with satisfaction. There is no advantage which justifies the additional cost of grinding, except for horses with bad teeth or weak digestive organs.

Millet, kafir, and milo seeds.—These are very small, hard grains which must be ground before they are suitable for the horse ration. They compare favorably with oats in regard to total nutrients, and any of them, when ground or rolled, may be used in combination with other grains, but it is

[8] For further information on the use of cottonseed meal as a horse feed, refer to U. S. Department of Agriculture Bulletin 929, "Cottonseed Meal for Horses."

well to limit the amount used to one-third the total concentrate allowance. The sorghum grains are high in carbohydrates and tend to cause constipation when fed heavily. These grains, therefore, should be fed in conjunction with a laxative protein feed, such as wheat bran, to counteract this tendency.

Dried brewers' or distillers' grains.—These grains, which are by-products of fermentation industries, are rather heavy protein concentrates and suitable for balancing carbonaceous rations or for incorporation with chopped mixtures, but are not suitable for use as the major part of the grain ration. They are not palatable and should be limited in amount to about one-fourth the total allowance of concentrates. Some feeders claim that these feeds have a tendency to cause constipation.

Gluten meal.—A by-product of starch manufacture, it is high in protein and fairly high in carbohydrates. It is classed as a protein concentrate, and should be limited to about one-fourth the total grain allowance. It is not very palatable, but sometimes is valuable for use in chopped mixtures.

Gluten feed.—This is also a protein concentrate but is somewhat less nutritious than gluten meal. Gluten feed is made by mixing corn bran with gluten meal, and is not very palatable. The proper use of gluten feed is for balancing more carbonaceous rations, and it should be limited in amount to one-third of the grain ration. Like gluten meal, it may well be used with other grains in a chopped mixture and fed with molasses.

Dried beet pulp.—A by-product of sugar manufacture, this pulp is unpalatable, but by mixing with molasses or other well-liked feeds, it may be included in the ration. It is very low in protein. Dried beet pulp is a safe feed, but it is not desirable to use it in excess of about 5 pounds in the daily ration, and it should be fed in connection with some feed that is relatively high in protein.

Cane molasses (blackstrap molasses).—The use of this feed is quite popular in cane-growing sections. It is high in carbohydrates and should be fed in connection with feeds relatively high in protein. Molasses is especially palatable and is well suited for combination with chopped mixtures containing nutritious but unpalatable feeds. It is usually desirable to dilute it with two parts of water before feeding over grain or roughage. The amount of molasses in the ration should be limited. Usually about 5 pounds daily is a very reasonable allowance, although some feeders use considerably more than that amount. Cane molasses is neither laxative nor binding in effect. Molasses is not usually an economical feed except in sugar-producing regions. However, it is often desirable to use a small amount, such as a quart (3 pounds) a day, as an appetizer.

Beet molasses.—As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain constituents stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate ration that also includes a protein feed.

Milk.—Sometimes milk may be used with good results for feeding horses. Its particular advantage is in its use for colts and for horses that are out of condition. Milk may also be a valuable feed for horses doing very light work. It is palatable, easy to digest, and valuable for fattening. If cow's milk is to be substituted for mare's milk for young colts, there should be an addition of a little sugar and a little limewater. It is not desirable to feed a large quantity of milk to horses generally, but 3 or 4 gallons a day can well be allowed a horse not doing heavy work. Milk is a safe feed, and even in clabbered condition it is not harmful.

Tankage and blood meal.—These by-products of slaughterhouses do not rank high as horse feeds. They are very high in protein, but are extremely unpalatable. They may be used, however, in amounts not exceeding 1 pound each day per animal in connection with some palatable carbonaceous mixture. Tankage and blood meal are used principally for young stock and for building up animals in extremely poor condition.

ROUGHAGES

Alfalfa hay.—This roughage is receiving very great favor as a horse feed. It contains nearly as much nutriment, pound for pound, as wheat bran. It is very high in protein and minerals; hence it is especially valuable for young stock. Alfalfa is somewhat laxative in effect. Because of this and its high protein content, it is well to limit the amount to one-half or two-thirds the roughage allowance. Tim-

othy hay may be used to make up the rest of the roughage supply. Alfalfa is especially suited for use with a grain ration that is low in protein. Corn as the grain, and alfalfa as the roughage, equal weights of each, very nearly make a balanced ration. In considering a roughage for horses, it is desirable to furnish one that is relatively high in nutriment, since the horse has a comparatively small stomach and is unsuited to take care of great quantities of nonnutritious material. Alfalfa meets this requirement. Because of its soft stems this roughage is often used in chopped mixtures.

Timothy hay.—This hay is highly recommended for horses. Notwithstanding the fact that it is not very high in nutrients, there is probably no other one form of roughage that is better suited for the horse ration. It is low in protein and is suitable for combination with alfalfa, clover, or some other legume. If timothy is fed as the only form of roughage, the concentrate allowance should be relatively high in protein. Because of its sharp, brittle stems it is not well suited for use in chopped mixtures. It is readily available in most sections of the country. Timothy hay and oats have long been regarded as the standard horse feeds, but the combination can be improved by including some feed that is relatively high in protein.

Clover hay.—This is a good feed for horses. The usual criticism of this hay is that it is often dusty. Dampening at the time of feeding will aid somewhat, but proper care in the curing of the hay is the best means of preventing dust. Bright clover hay that is free from dust is almost as valuable as alfalfa. It is more palatable than timothy, and a mixture of clover and timothy is to be preferred to timothy alone as a roughage for horses. Clover is a legume, high in protein, somewhat laxative in effect, is an excellent feed for colts, and is suited for use in connection with a grain ration that is rather low in protein. Where only one kind of hay is fed, a smaller quantity is required of clover than of timothy. Various kinds of clovers are used for hay in different parts of the country. Common red clover is most widely used. Mammoth or Big English clover is acceptable, but is somewhat coarse. The very coarse, large varieties, such as sweet clover, are usually too woody to be very desirable. Alsike is very good, but the yield of this crop is usually not large enough to encourage its growth in most localities. If hay from crimson clover is to be used as a horse feed, the crop should be cut before the blossoms are ripe, as the hairy growth on the head of the plant becomes wiry and indigestible and forms masses similar to hair balls, in the digestive tract, which often result in serious cases of impaction. Bur clover of the South may be used as a hay for horses, but its use is not common.

Corn stover.—Corn fodder from which the grain has been removed is a common feed for horses. The objections to it are that it is usually so carelessly handled that most of the nourishment is lost, and that the feed is allowed to become partly spoiled. It is also unhandy to feed unless some special preparation is given, and there is usually considerable waste connected with feeding it. However, corn stover that is bright and clean and which retains its leaves is very palatable, desirable, and safe for horses, and is suitable for use as the sole roughage during the fall and early winter. It is low in protein and should be fed in combination with a concentrate ration which will offset the deficiency. Cutting or shredding is usually advisable if it is to be fed in the stable.

Oat hay.—Hays from oats and similar cereals are commonly fed to horses. These crops should be cut before maturity if they are to be used as forage. They are palatable and nourishing, and care should be taken that the amount is limited. On account of the grain, the allowance should be about one-third less than would be fed in the case of the more common roughages. Very little concentrated feed is needed with oat hay, but it is desirable to include a feed relatively high in protein. Cereal hay may be fed as half the roughage allowance in connection with a legume hay. With such a combination only about half the usual grain ration is necessary.

Cowpeas, soy beans, velvet beans, and field peas.—These may be used as hay for horses. All are legumes, high in protein, and suitable for use in connection with concentrates that are high in carbohydrates, such as corn or molasses. The peas and beans are slightly laxative in effect. It is well to limit these feeds to one-half the roughage allowance; timothy or prairie hay may well be used to form the other half. The amount of grain in the pods should be taken into consideration, and the ration of concentrates should be reduced accordingly.

Field-pea vines that have been carefully cured after the peas have been threshed out are fairly acceptable as horse forage. A full grain ration and a little hay should be fed with them. Unthreshed cowpeas, soy beans, velvet beans, and field peas are safe and fairly palatable feeds, but are too concentrated to form the complete roughage allowance.

Millet, or Hungarian hay.—This is suitable for use in the horse ration, provided the crop has been cut before it is too mature and that an excessive quantity is not fed. The small, hard seeds of mature millet are objectionable, as harmful action on the kidneys is claimed when an excess of these is fed. This hay is carbonaceous in character and should be fed in connection with a legume hay, or the concentrate allowance should contain feeds a little high in protein. Bright millet hay of fine growth is quite satisfactory as a horse feed when limited to half the roughage allowance.

Prairie hay.—This hay is satisfactory for use as a horse feed and is commonly used in the West. It is slightly lower in nutrients than timothy hay, is carbonaceous, and should be fed in combination with a legume hay. It is a safe feed, fairly palatable, and may form the total roughage allowance if the concentrate ration is sufficiently high in protein.

Orchard-grass hay.—Orchard grass makes a suitable hay for horses only when it is cut before maturity. It compares very favorably with timothy, and its palatability is not criticized in hay that is not too mature when cut. It is carbonaceous, and when used either the concentrates should be high in protein or a legume hay should form part of the roughage allowance. It is a safe feed for horses.

Johnson grass.—In certain sections of the South, particularly throughout the Cotton Belt States, Johnson grass grows luxuriantly, often producing three cuttings of good hay a year and forming excellent pasturage. In this district this grass may be utilized to advantage as forage for horses. Johnson grass is a carbonaceous roughage which has a feeding value equivalent to timothy, is slightly laxative in character, and is eaten with relish by horses. The principal drawback to feeding Johnson-grass hay in those sections where clean cultivation of other crops is practiced lies in the fact that such feeding distributes the seeds of the plant and makes the confinement of its growth to a limited area very difficult.

Brome grass.—This grass is of carbonaceous character and is common in the North and West. The hay is palatable and safe for horses. It is a little low in protein, and the grain ration that is fed with it should include a protein concentrate.

Straw.—Straw from various cereals such as oats, barley, wheat, rye, and rice, is often used as a feed for horses. It is bulky, nonnutritious, and is not especially suitable, since the horse has a comparatively small stomach and its digestive anatomy is in no way suited to handle a large amount of bulky feed. So very little nourishment is derived from straw that it is not considered a suitable feed for animals doing hard work. Straw is carbonaceous, and its principal use is for idle horses. Some laxative feed should be fed in connection with it. Because of economy, it is often desirable to feed some straw, and in this case the concentrate allowance should be high in protein. A little straw may be included in a ration in which the principal roughage is alfalfa, clover, or some other legume. Oat straw is preferable; barley straw and wheat straw are good; straw from buckwheat or rye is not desirable; straw from rice is sometimes fed with good results when the remainder of the ration is high in protein. The economy of feeding straw is a factor which can not be disregarded, but the practice should not be carried to the extreme, and care should be taken to supply sufficient protein through the concentrate ration.

Vetch.—This legume is not very commonly used as a horse feed. The plant is rich in nutrients, is suitable to form about half of the roughage allowance in a ration that is lacking in protein, and is fairly palatable. A combination that is meeting with favor is vetch and oat hay.

Sudan grass.—This plant makes a suitable hay for horses and is fairly palatable. As a carbonaceous feed the hay is suitable for use as part of the roughage allowance in combination with a legume hay. Its principal use is in the South.

Bermuda grass.—Hay from this plant is sometimes used in the South. It is a carbonaceous feed, suitable for use in connection with legume hay for the roughage allowance. If fed alone

the concentrate allowance should be high in protein.

Sorghum.—Fodder from sorghum may be used as dry forage for horses but does not keep for a great length of time. It is especially high in carbohydrates, is palatable and suitable for use in connection with feeds which are high in protein.

Pumpkins.—As a succulent feed for horses pumpkins have a fair value, their feeding value being about two-fifths that of silage, and their main use for improving digestion. The seeds have a laxative effect. It is not advisable to feed pumpkins which have been frosted. They are not usually fed in great amount and should be limited to about 8 pounds daily. No other laxative feed should be included in the same ration, there should be a slight decrease in the amount of roughage, and provision should be made for feeds relatively high in nutrients to balance the ration.

Silage.—Silage should not be considered as one of the principal roughages for horses. Its use is as a succulent, an appetizer, and tonic to be fed in limited quantities as a supplement to the regular ration. When used, this feed must be introduced gradually into the ration. It is a very dangerous practice to feed molded or frozen silage to horses. Corn silage is the only kind that has met with any degree of favor as a horse feed. It has a valuable place in the winter ration if fed with care. The amount should not exceed 10 pounds daily per animal.

WATER

There is a diversity of opinion among horsemen on the question of watering horses. Some feeders maintain that horses should always be watered before feeding in order to prevent a flushing of the grain through the stomach into the small intestine. This system is not always practicable, however, as some animals will refuse to drink before eating. The consensus of opinion on watering horses indicates that water may be given either before, during, or after meals without injurious effects. Thus, individual convenience and attendant circumstances will largely determine the watering practice to be followed. In any practice, however, it is well to adhere to the same plan, once a definite watering time has been adopted, for to change frequently from one system to another will affect the animal's appetite. Regularity in watering methods as well as feeding methods should be adhered to.

The following factors should be considered in watering horses:

Horses which have been deprived of water for a long period or those which have undergone severe exertion should generally be watered before eating. It is dangerous, however, to allow an animal to drink heavily while very warm. If the horse is hot, give a moderate drink at this time, and water more freely when the animal is cool.

It is not a good practice to water heavily just before putting horses to heavy work.

Weather conditions, the nature of the work done, and the kind of feed consumed will determine the quantity of water required. In hot weather and when at hard work, horses consume more water than in cold weather or when inactive. Horses will drink more water when fed a protein-rich ration, such as alfalfa hay, than when on a carbonaceous diet.

The average water consumption per individual horse is from 10 to 12 gallons daily.

One of the times when a horse requires and appreciates a drink most is when it has finished its nightly allowance of roughage. Every horse should be allowed to drink at this time if possible.

It is better to water frequently, in small quantities, than to allow the animal to gorge itself at any one time.

Watering at public troughs is to be avoided, as this is a common method of spreading disease.

SUCCULENT FEEDS

Pasture.—Pasture is foremost among the succulent feeds for horses. It acts as a laxative and general tonic to the system, is an appetizer, and a valuable feed. Succulent feeds are watery and do not produce solid flesh. While pasture alone is sufficient to maintain idle horses, it is well to consider the relative feed value of the pasture crop and the general condition of the pasture. Usually it is advisable to feed a light grain ration relatively high in protein in connection with pasture, even when the horses are idle. Pasture is very valuable in the management of work teams; regularly allowing horses the freedom of pasture during the night and on idle days enhances the health of the animals. There will be an increased tendency

toward sweating while at work but this is not of great importance when the benefits are considered. For work horses that are given pasture, other laxative feeds should be taken out of the ration. Timothy hay may be used as the roughage, and the concentrate allowances should include grains that are not laxative in character, thus making a properly balanced ration. A necessary precaution is to avoid a sudden change to green feed; where a pasture crop is included in the ration for work horses, the pasturing should be continuous, not intermittent.

Soiling crops.—Most of the forage crops previously mentioned under "Roughages" may be cut green and fed to horses. This practice is probably most common with corn. Care should be taken, however, to prevent sudden changes to this type of green feed. There is also danger of the crop's spoiling before being fed; therefore, the green feeds should be used only when fresh. The balancing in regard to nutrients should be the same for soiling crops as for pasture. The pasture system provides exercise and on this account is far preferable to soiling.

Roots.—Carrots, parsnips, rutabagas, and beets are succulent feeds used principally as an aid to digestion. Their use in the horse ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed other laxative feeds should be omitted, the roughage supply should be decreased, and the grain ration should contain feeds high in nutrients. Chopping the roots is usually advisable.

Potatoes.—Potatoes are relatively high in food value, are palatable, and are well suited for use as a horse feed where the cost is not prohibitive. It is safe to feed as high as 15 pounds a day to work horses. They are equivalent to about one-third their weight in hay. When potatoes are fed, a legume hay is a desirable supplement. If a carbonaceous hay is fed, the grain ration should contain feeds rich in protein. Potato sprouts are injurious to horses and should be removed. It is advisable to chop potatoes before feeding, as the danger from choking is thereby lessened.

Fruits.—When without stones, fruits may be used for feed and are much relished by horses. This addition to the ration is as an appetizer and relish rather than as a nutritious feed. Fruits are low in protein, and if used in considerable amount the main ration should be nitrogenous in character. Ten pounds of fruits daily are not harmful.

SALT

Horses should be given salt at frequent, regular intervals, or, better, salt should be accessible at all times. When salt is given regularly, only enough to meet the body requirements will be consumed, while with irregular use an abnormal appetite develops for it, which, in turn, is often followed by an excessive consumption and digestive troubles if unlimited access is allowed. An average of about three-quarters of an ounce daily should be allowed under normal conditions. Horses doing heavy work, however, or those on dry feed will consume more than this quantity.

Aside from its value as a feeding requisite, salt is of benefit as an appetizer, for in many instances delicate eaters and shy drinkers will show an increased appetite when allowed free and regular access to it.

STOCK FEEDS AND CONDIMENTS

The stock and condimental feeds that are generally bought on the market, which are represented to be conditioners, tonics, and fatteners, have for their foundation simple, well-known drugs, and feeds. If a tonic or feed is desired, one of known composition may be mixed at home with entirely satisfactory results. The following formulas are suggested:

I		II	
Glauber salt	2 pounds.	Glauber salt	5 pounds.
Soda	1 pound.	Saltpeter	1½ pounds.
Salt	1 pound.	Fenugreek	1 pound.
Fenugreek	2 ounces.	Gentian	2 pounds.
Linseed meal	25 pounds.	Linseed meal	50 pounds.

A heaping tablespoonful of one of the foregoing mixtures fed with the grain three times a day is sufficient.

When a tonic is needed it is advisable to investigate why it is needed. The horse should receive daily attention regarding feed, water, salt, exercise, grooming, sanitation, and comfortable quarters. Neglect of any of these factors is usually an underlying cause of the poor condition of an animal.

SUGGESTED DAILY RATIONS

The following daily rations have been prepared with a view of suggesting combinations of feeds that will suit conditions in various parts of the country, and from which the feeder may derive rations that will meet his local needs. Attention is invited to the fact that the rations suggested are for a horse weighing 1,000 pounds, and modification of these rations should be made for heavier or lighter horses. For example, in order to meet the requirements for a horse weighing 1,250 pounds the rations suggested should be increased in accordance with the increase in weight, which in this case is 25 per cent. Roughly this would give the feed requirement for the heavier horse.

Maintenance rations for 1,000-pound idle horse

[Theoretical daily requirement, 0.60 pound of protein and 7.30 therms of energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
5 pounds ear corn	0.280	3.420	4 pounds rolled barley	0.332	3.5976
3 pounds alfalfa hay	.213	1.0269	4 pounds alfalfa hay	.284	1.3692
9 pounds corn stover	.144	2.8458	7 pounds barley straw	.042	2.5627
	.637	7.2927		.658	7.5295
4 pounds oats	.348	2.7024	4 pounds alfalfa hay	.284	1.3692
4 pounds clover hay	.196	1.5472	14 pounds corn fodder with ears	.322	6.1516
10 pounds oat straw	.08	3.481		.606	7.5208
	.624	7.7306	2 pounds shelled corn	.140	1.710
8 pounds alfalfa	.568	2.7384	4 pounds oat hay	.156	1.290
8 pounds oat straw	.064	2.7848	10 pounds orchard-grass hay	.330	4.493
3 pounds cane molasses	.000	1.6614		.626	7.493
	.632	7.1846	3½ pounds shelled corn	.245	2.9925
5 pounds cowpea hay	.460	1.8795	3 pounds cowpea hay	.276	1.127
5 pounds silage (corn)	.030	.7950	10 pounds oat straw	.08	3.481
10 pounds timothy hay	.220	4.3020		.601	7.60
	.710	6.9765			

Daily rations for 1,000-pound horse, very light work

[Theoretical requirement, 1 pound protein and 9.80 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
10 pounds ear corn	0.56	6.840	5 pounds shelled corn	0.35	4.275
5 pounds alfalfa hay	.355	1.711	2 pounds cowpeas	.338	1.5892
5 pounds timothy hay	.110	2.151	½ pound cottonseed meal [1]	.177	.4672
	1.025	10.702	5 pounds corn stover	.08	1.581
			5 pounds sorghum fodder	.075	1.610
8 pounds oats	.696	5.4048		1.02	9.5225
4 pounds alfalfa hay	.284	1.3692			
6 pounds timothy hay	.132	2.5812	7 pounds shelled corn	.490	5.985
	1.112	9.3552	1 pound cottonseed meal	.354	.9346
			4 pounds cowpea hay	.368	1.5036
5 pounds cowpeas (coarsely ground)	.845	3.9730	6 pounds corn stover	.096	1.8972
5 pounds molasses	.000	2.7690		1.308	10.3204
10 pounds oat straw	.080	3.481			
	.925	10.223	8 pounds shelled corn	.560	6.840
			4 pounds cowpea hay	.368	1.5036
8 pounds rolled barley	.664	7.1952	6 pounds corn stover	.096	1.8972
4 pounds alfalfa	.284	1.3692		1.024	10.2408
5 pounds prairie hay	.145	2.021			
	1.093	10.5854			

[1] The meal may be replaced by 1 pound of cowpeas.

Daily rations for 1,000-pound horse at medium work

[Theoretical requirement, 1.40 pounds protein and 12.40 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
13 pounds ear corn	0.728	8.892	11 pounds shelled corn	0.770	9.405
6 pounds alfalfa hay	.426	2.0538	6 pounds cowpea hay	.552	2.2554
7 pounds timothy hay	.154	3.0114	6 pounds corn stover	.096	1.8972
	1.308	13.9572		1.418	13.557
12 pounds oats	1.044	8.1072	5 pounds cowpea hay	.460	1.8795
1 pound cowpeas (cracked)	.169	.7946	9 pounds corn stover	.144	2.8458
11 pounds timothy	.242	4.7322	10 pounds shelled corn	.700	8.550
	1.455	13.6340	½ pound cottonseed meal	.177	.4673
				1.481	13.7426
10 pounds rolled barley	.83	8.9940			
6 pounds alfalfa hay	.426	2.0538			
5 pounds prairie hay	.165	2.021			
	1.421	13.0688			

Daily rations for 1,000-pound horse at severe work

[Theoretical requirement, 2 pounds protein and 16 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
12 pounds oats	1.044	8.1072	10 pounds rolled barley	0.830	8.9940
2 pounds bran	.216	1.0600	2 pounds gluten meal	.562	1.6830
8 pounds timothy hay	.176	3.4416	8 pounds alfalfa	.568	2.7384
5 pounds clover hay	.245	1.9340	6 pounds prairie hay	.174	2.4252
	1.681	14.5428		2.134	15.8406
12 pounds shelled corn	.840	10.260	5 pounds cowpea hay	.460	1.8795
1 pound soy beans (ground)	.273	.8129	9 pounds corn stover	.144	2.8458
12 pounds alfalfa	.852	4.1076	13 pounds shelled corn	.910	11.115
4 pounds corn stover	.084	1.2648	1½ pounds cottonseed meal	.531	1.4019
	2.049	16.4453		2.045	17.2422
7 pounds peanuts (ground with hull)	1.183	5.8205			
7 pounds cane molasses	.000	3.8766			
7 pounds pea hay	.644	2.6313			
7 pounds timothy hay	.154	3.0114			
	1.981	15.3428			

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FEEDING HORSES

THE SELECTION of the most suitable ration for horses is governed largely by local conditions. Choose those feeds which meet the requirements of economy, nutrition, and convenience.

Make slight changes in feeds occasionally. A horse appreciates a variety in his diet.

Knowledge of individual requirements of horses is essential to obtain best results. Close observation is probably a more vital factor in the feeding of horses than in the feeding of any other class of livestock.

This bulletin explains the computation of rations for horses, suggests certain feed combinations which approximately meet the needs of horses under varying conditions, and reviews such factors of feeding as tend to make the horse more efficient.

Washington, D. C.

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Slightly revised November, 1934

FEEDING HORSES

By G. A. BELL, formerly *Senior Animal Husbandman*,[1] and J. O. WILLIAMS, *Senior Animal Husbandman in Horse and Mule Investigations, Animal Husbandry Division, Bureau of Animal Industry*

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STUDY OF RATIONS NECESSARY

The computation of rations is valuable as a guide to the feeder in determining approximate rations from a large variety of feeds. It is useful, also, in determining the requisite amount of nutrients, so that each will be supplied without waste. Results in feeding a ration should be observed and the ration modified according to the age, size, and condition of the horse. The amount and kind of work performed will determine the kind and quantity of feed to use.

There is far more economy in supplying the required amounts of nutrients in the right proportions than in providing an excess of one and a deficiency of another. Proper attention given to the matter of balancing horse rations will result in benefit to both the health and the working efficiency of the animals fed, which in turn will effect a material reduction in the enormous annual feed bill charged against the horses of the country.

LOCAL INFLUENCES IMPORTANT

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, combinations of home-grown or locally raised crops constitute the most economical rations. Choose from the feeds available those which will most closely meet the requirements of economy, nutrition, and convenience. Substitution may often be made in rations in such a manner that, while the efficiency remains unchanged, the cost is materially lowered. Selection of the most economical and suitable ration is governed largely by local conditions.

CONDITIONS AFFECTING FEED REQUIREMENTS

The kinds of feed used, the quantity required per animal, and the manner of feeding depend on the age, size, and condition of the horse, the amount and kind of work done, and the individual fed.

The horse at work requires more and richer feed than the idle one. To furnish energy for work, the feed allowance must be in excess of that needed for body maintenance. The amount of feed needed for maintenance is about two-thirds that required for a horse at moderate work. If the work done calls for more energy than is furnished in the ration, the stored-up energy of the body fat or other tissues will be drawn on, with a consequent loss in body weight and energy. If such feeding practice is continued, the horse will be so weakened constitutionally that he will be unable to perform his work profitably

[1] Mr. Bell resigned from the department Oct. 15, 1920.

and also will be especially susceptible to disease.

Horses of the same type and weight may have different feed requirements, which makes it necessary to study the individuality of the animals. If the horse is not doing well on a ration, a slight change should be made. Any change, however, should be made gradually in order to avoid digestive disturbances.

SELECTING A RATION

As no feed or combination of feeds will meet conditions in all parts of the country, so no feed or mixture of feeds is suitable for all classes of horses. In choosing a ration for a horse, select the one that seems to meet best his requirements, whether for growth, maintenance, work, breeding, or fattening; estimate the amount of feed needed, and try out the ration. It may appear after a trial that too little is being fed or that the ration may be changed somewhat in the interest of either economy or efficiency. If a number of horses are kept, different rations may be tested on different animals and the best one selected for general use. Individual feeding gives the best results.

PREPARATION OF FEEDS

The advisability of chopping, cutting, or chaffing hay for horse feeding depends largely on the cost of preparation, the quality of the feed, and its price. Ordinarily, low-priced hay of good quality should not be prepared for feeding, but it may be economical to chop, cut, or chaff poor-quality hay, as it is eaten with less waste than the unprepared forage.

Such roughages as corn stover and sorghum can generally be fed to horses most satisfactorily when shredded or cut. Preparation makes the feed much easier to handle in the stable and results in a greater proportionate consumption of the roughage.

The benefits derived from grinding or crushing oats and corn for horses depend on the cost of preparation, working conditions, and the condition of the animals' teeth. Throughout the Corn Belt corn is usually fed on the cob or in the shelled form, and it ordinarily does not pay to grind it for horses unless the animals' teeth are in poor condition or if there is not time enough for proper mastication of the grain. All small, hard grains, such as rye, barley, rice, and wheat, should be crushed or rolled before feeding, to avoid digestive disturbances, since horses can not properly masticate those grains.

Ordinarily it is not advisable to cook, steam, or soak feeds for horses, since those methods of preparation do not materially improve digestion. When, however, the small, hard grains can not be rolled or crushed, it is a good plan to soak them. It is the accepted practice, moreover, of many horsemen to feed a warm mash occasionally as a tonic and to regulate the bowels.

BALANCING A RATION

Feeding stuffs are broadly divided into two general classes, protein and carbohydrate. The protein feeds are rich in nitrogenous compounds which are used by the animal body in building tissue, bone, hair, etc., and to provide energy. The carbohydrate feeds are starchy in nature and are used by the animal body in the formation of fat and for energy and heat.

To obtain the best results in feeding, the ration should be so balanced that it properly meets the needs of the animal in building tissue and in supplying energy for work. In order to do this, feeds containing the nutrients which supply the required proteins and energy are needed in certain proportions to meet the body requirements. If feeds deficient in protein are fed an excessive amount of carbonaceous nutrients must be consumed in order that the system may obtain the required quantity of protein, and vice versa, and so a waste of feed will be the result. It is essential, therefore, that a balanced ration be fed, that is, one containing proteins and carbohydrates in such proportions that the requisite amounts of each will be utilized without waste.

Feeds rich in protein are usually the most expensive. If more protein is supplied than is needed for nutrition, the cost of the feed is unnecessarily increased. It is more economical to supply the energy necessary to perform work in the form of carbohydrates than proteins. Thus for mature horses at work and for maintaining idle horses the protein feed allowance may be limited to the amount necessary to build tissue, and a large proportion of carbohydrates may be fed.

FEEDING HINTS

The grain part of the ration for horses at work is usually divided into three equal feeds. If the horse does

not clean up grain in a reasonable length of time, the quantity should be reduced. About two-thirds of the daily hay allowance is given at night, with most of the remainder fed in the morning, leaving only a very small allowance for the noon feed. The quantity of roughage should be limited within the maximum allowance, so that all the edible forage will be cleaned up every day. When there is forage remaining from the night feeding, do not put in a fresh supply, but stir up that which is in the manger, so that the chaff goes to the bottom, leaving the good hay available. Some hay should be fed before the grain at night, for the appetite of the horse is not appeased by the grain when it is fed first, and it fills up on hay, forcing the grain on through the stomach too quickly, thereby decreasing the quantity assimilated.

The method of feeding has a great deal to do with the utilization of the feed and the condition of the horse. It is important that the horse that bolts grain be made to eat slowly, which may be done by feeding the grain spread out in a large, flat box, by placing several smooth stones about 3 inches in diameter in the feed box, or by mixing it with bran, cut hay, or similar feed. Some horses waste their hay by pulling it out and trampling it under foot. This is sometimes caused by feeding two kinds of hay, one of which is especially palatable. In that case, the waste may be corrected by feeding the hay so that the horse can eat the more palatable first. The horse will then eat the other hay leisurely during the night. Another plan is to withhold the good hay until the other is eaten.

Overfeeding, rather than underfeeding, is the common practice when horses are working irregularly. It should be remembered that the amount of feed should vary, not only between winter and summer but also from day to day. It is a waste of feed if the amount is not varied with the degree of work.

FEEDING IDLE HORSES

Maintaining the farm work horse in healthful condition during the winter is the first start in fitting it for spring work. The horse should not be so fed during the winter that it becomes fat and soft. Moreover it is bad management to let a horse lose weight during the winter and then try to bring it back to normal by heavy feeding just before the beginning of spring work.

The liberal use of roughage, supplemented with the right quantity and kind of other nutritious feed, will maintain a horse properly during the winter. Farm horses, except brood mares or growing stock, do well on a ration made up largely of the coarser hays, straw, or corn fodder. Cornstalk fields, grain-stubble fields, or pastures which have not been too closely grazed during the summer are very desirable sources of a large part of the winter maintenance feed. The common roughages, as the main part of the ration during this period, will supply bulky feed enough to keep the horse thrifty without putting on superfluous fat. The drinking of a large quantity of pure water should be encouraged to increase the utilization of these dry roughages. When necessary, a tank heater should be used to keep the drinking trough free from ice.

It is advisable to supplement the coarser roughages with a legume, such as alfalfa, clover, vetch, soy-bean, or cowpea hay. These hays are very palatable and should be fed sparingly. They are rich in protein and mineral matter and supply the materials needed to replace those lost in the natural wear of the body. Being somewhat laxative in effect they also help to keep the digestive tract in good condition. They are especially valuable in connection with straw and similar feed. The use of these hays with the coarser roughages is economical because a supplemental ration of grain is not ordinarily necessary.

In some instances, especially when it is not possible to feed a legume hay, a small quantity of grain is necessary to maintain the horses in thrifty condition. Oats are preferred for use with coarser roughages, but corn and barley are often used in the winter ration, especially when they are cheaper or when an increase in weight is desired. One or two bran mashes a week or a little linseed meal each day is recommended as an aid in keeping the system in good condition and in preventing impaction resulting from the use of large quantities of coarse roughage improperly supplemented.

Pregnant mares require more attention during the winter than the open mare or gelding. Leguminous feeds high in protein and ash are necessary in developing the fetus. Although the feeding of legume hay is usually of more importance than a supplemental grain feed, in most cases such feeds as oats, bran, and oil meal should be supplied, the proportions being largely controlled

by the condition of the mare and the stage of development of the fetus.

THE COMPUTATION OF RATIONS [2]

The computation of rations is not difficult, and a little time spent on calculations enables the feeder to provide, from available feeds, a ration which will approximately supply the requisite amounts of protein and carbohydrates. Data on rations will afford valuable aid to the feeder, but he must observe results and modify his feeding accordingly.

The rations given in this publication are based on the true protein and the net energy values of various feeding stuffs. The net energy value is the measure of the true value of the feed as a source of energy to the animal organism after deducting the losses in the unburned materials in the excreta and the energy expended in extracting the real fuel materials from the feed consumed. For example, while 100 pounds of corn meal contain about 187 therms of chemical energy, only about 85 therms remain, after the above-mentioned deductions have been made, to represent the actual value of the meal as a source of energy to the animal.

The following table is adapted from a similar one published in Department Bulletin 459, and gives the true protein and net energy values per 100 pounds of feeding stuffs for ruminants. It may be regarded as expressing with sufficient accuracy the relative value of feeding stuffs for horses. A column has been added designating the group in which some of the common feeds are ordinarily classified. This is done in order to simplify the selection of feeds for compounding a ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DRIED ROUGHAGE				
Hay and fodder from cereals		*Pounds*	*Pounds*	*Therms*
Brome grass, smooth	Carbohydrate	91.5	3.5	40.83
Corn (maize) fodder (ears included, medium dry)	do	81.7	2.3	43.94
Corn (maize) stover (ears removed, medium dry)	do	81.0	1.6	31.62
Kafir fodder, high in water	do	71.7	1.8	34.28
Kafir stover, high in water	do	72.7	1.0	27.65
Millet, Hungarian	do	85.7	3.9	46.96
Timothy and clover mixed		87.8	3.6	40.85
Oat hay	Carbohydrate	88.0	3.9	32.25
Orchard grass	do	88.4	3.3	44.93
Prairie hay	do	93.5	2.9	40.42
Red top	do	90.2	3.9	51.22
Sorghum fodder, computed to 80 per cent dry matter	do	80.0	1.5	32.30
Timothy, all analyses	do	88.4	2.2	43.02
Hay and fodder from legumes				
Alfalfa, all analyses	Protein	91.4	7.1	34.23
Clover, alsike	do	87.7	5.3	34.42
Clover, crimson	do	89.4	6.9	36.21
Clover, red, all analyses	do	87.1	4.9	38.68
Clover, sweet white	do	91.4	6.7	39.98
Cowpeas, all analyses	do	90.3	9.2	37.59
Soy beans	do	91.4	8.8	44.03
Straws				
Barley	Carbohydrate	85.8	.6	36.61
Buckwheat	do	90.1	3.2	4.55
Oat	do	88.5	.8	34.81
Rice	do	92.5	.4	23.63
Rye	do	92.9	.5	17.59
Wheat	do	91.6	.3	7.22

[2] For detailed information, consult U. S. Department of Agriculture Bulletin 459, The Use of Energy Values in the Computation of Rations for Farm Animals. Out of print, but may be consulted in libraries.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
FRESH GREEN ROUGHAGE				
Green cereals, etc.		*Pounds*	*Pounds*	*Therms*
Barley fodder		23.2	2.0	14.08
Bluegrass, Kentucky, before heading		23.8	2.8	14.82
Bluegrass, Kentucky, headed out		36.4	2.2	17.77
Bluegrass, Kentucky, after bloom		43.6	1.6	21.01
Buckwheat, Japanese		36.6	1.5	17.78
Cabbage		8.9	1.3	8.87
Corn (maize) fodder, dent, all analyses		23.1	.8	14.60
Corn (maize) fodder, flint, all analyses		20.7	.8	13.53
Corn (maize) fodder, sweet, roasting ears or later		20.3	.9	13.38
Corn (maize) fodder, sweet, ears removed		21.5	.8	14.26
Millet, Hungarian		27.6	1.1	17.24
Oat fodder		26.1	2.0	14.06
Orchard grass		29.2	1.1	15.81
Rape		16.7	1.7	13.07
Rye fodder		21.3	1.4	15.99
Sorgo fodder		24.9	.4	15.37
Timothy, before bloom		24.2	1.1	18.36
Timothy, in bloom		32.1	.8	18.89
Timothy, in seed		46.4	1.0	26.36
Wheat fodder		27.4	1.9	18.75
Green legumes [1]				
Alfalfa, before bloom		19.9	1.9	9.20
Alfalfa, in bloom		25.9	1.8	11.50
Alfalfa, after bloom		29.8	1.3	11.10
Clover, alsike		24.3	1.5	14.56
Clover, crimson		17.4	1.6	10.83
Clover, red, all analyses		26.2	1.7	15.87
Clover, red, in bloom		27.5	1.8	16.74
Clover, red, rowen		34.4	2.2	17.30
Cowpeas		16.3	1.7	10.42
Peas, Canada field		16.6	2.1	9.78
Soy beans, all analyses		23.6	2.4	12.53
Vetch, hairy		18.1	2.4	11.95
SILAGE [1]				
Corn (maize), well-matured, recent analysis		26.3	.6	15.90
Corn (maize), immature		21.0	.4	11.96
Corn (maize), from field-cured stover		19.6	.3	8.98
Clover		27.8	.8	7.26
Cowpeas		22.0	1.1	11.05
Soy beans		27.1	1.5	11.59
Sugar-beet pulp		10.0	.5	9.32
ROOTS, TUBERS, AND FRUITS [1]				
Apples		18.2	.1	15.92
Beets, common		13.0	.1	7.84
Beets, sugar		16.4	.4	11.20
Carrots		11.7	.5	9.21
Mangels		9.4	.1	5.68
Potatoes		21.2	.1	18.27
Pumpkins, field		8.3	.6	6.05
Rutabagas		10.9	.3	8.46
Turnips		9.5	.4	6.16
GRAINS				
Cereal grains				
Barley	Protein	90.7	8.3	89.94
Buckwheat	do	87.9	7.2	59.73
Corn (maize), dent	Carbohydrate	89.5	7.0	85.50
Corn (maize), flint	do	87.8	7.2	84.00
Corn (maize) and cob meal	do	89.6	5.7	75.80
Corn (maize) meal	do	88.7	6.4	85.20
Oats	Protein	90.8	8.7	67.56
Oatmeal	do	92.1	11.5	86.20
Rice, rough	Carbohydrate	90.4	4.5	77.33
Rye	Protein	90.6	9.0	93.71
Sorghum grain	Carbohydrate	87.3	6.7	89.75
Wheat, winter	Protein	89.1	7.7	91.66
Wheat, spring	do	89.9	8.1	91.41

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
GRAINS—continued				
Leguminous seeds		*Pounds*	*Pounds*	*Therms*
Beans, navy	Protein	86.6	16.4	73.29
Cowpeas	do	88.4	16.9	79.46
Peas, field	do	90.8	16.6	78.72
Pea meal	do	89.1	17.2	77.62
Peanuts with hull	do	93.5	16.9	83.15
Peanut kernel	do	94.0	22.2	109.04
Soy beans	do	90.1	27.3	81.29
Oil seeds				
Cottonseed	Protein	90.6	11.9	78.33
Flaxseed	do	90.8	19.2	83.17
Sunflower seed	do	95.5	20.2	95.77
Sunflower seed with hulls	do	93.1	11.7	92.49
DAIRY PRODUCTS				
Buttermilk	Protein	9.4	3.4	13.32
Cow's milk	do	13.6	3.3	29.01
Skim milk—centrifugal	do	9.9	3.6	14.31
Skim milk—gravity	do	9.6	3.1	15.43
Skim milk—dried	do	91.7	34.4	103.91
Whey	Carbohydrate	6.6	.8	10.39
Milling				
Buckwheat bran	Protein	88.8	9.1	30.59
Buckwheat hulls	Carbohydrate	89.7		−7.69
Buckwheat middlings	Protein	88.0	20.8	72.19
Hominy feed	Carbohydrate	89.9	6.5	88.78
Red-dog flour	Protein	88.9	13.2	78.80
Rice bran, high-grade	Carbohydrate	89.9	7.0	45.29
Rice meal	do	90.5	6.4	65.24
Rice polish	do	90.0	7.1	77.70
Rye bran	Protein	88.6	10.5	79.35
Wheat bran	do	89.9	10.8	53.00
Wheat middlings, flour	do	89.3	14.0	75.02
Wheat middlings, standard	do	89.6	12.0	59.10
Oil extraction				
Coconut meal, low in fat	Protein	90.4	18.3	83.49
Coconut meal, high in fat	do	92.3	18.0	100.31
Cottonseed hulls	Carbohydrate	90.3		9.92
Cottonseed meal, choice	Protein	92.5	35.4	93.46
Cottonseed meal, prime	do	92.2	32.0	90.00
Linseed meal, new process	do	90.4	30.9	85.12
Linseed meal, old process	do	90.9	28.5	88.91
Peanut cake from hulled nuts	do	89.3	41.4	93.55
Peanut cake, hulls included	do	94.4	19.5	42.57
Soy-bean meal, fat extracted	do	88.2	37.3	99.65
Sunflower-seed cake	do	90.0	29.1	88.87
Starch manufacturing				
Gluten feed	Protein	91.3	20.1	80.72
Gluten meal	do	90.9	28.1	84.15
Starch feed, dry	Carbohydrate	90.9	9.2	77.46
Starch feed, wet	do	33.4	3.7	30.45
Sugar manufacture				
Molasses, beet	Protein	74.7		57.10
Molasses, cane or blackstrap	do	74.2		55.38
Molasses beet pulp	do	92.4	3.5	76.28
Sugar-beet pulp, dried	do	91.8	.7	75.87
Sugar-beet pulp, ensiled	do	10.0	.5	9.32
Sugar-beet pulp, wet	do	9.3	.5	8.99
Packing house				
Dried blood	Protein	90.3	68.6	68.12
Tankage:				
Over 60 per cent protein	do	92.6	55.6	93.04
55–60 per cent protein	do	92.5	51.1	83.58
45–55 per cent protein	do	92.5	45.5	72.96
Below 45 per cent protein	do	93.5	35.6	54.16

REQUIREMENTS FOR WORK

Rations containing the following amounts of digestible protein and of net energy value may be used as a guide in computing daily rations for the 1,000-pound work horse under varying conditions:

Kind of work	Digestible protein	Net energy value
	Pounds	*Therms*
For light work	1.0	9.80
For medium work	1.4	12.40
For heavy work	2.0	16.00

(Dry matter: For the 1,000-pound horse, from 16 to 25 pounds is a fair average, depending on the amount of work performed.)

METHOD OF COMPUTING RATIONS

Following is an example in computing a ration that will meet approximately the needs of a 1,000-pound horse or mule at medium work:

From the table above we know the requirement to be 1.4 pounds digestible protein and 12.4 therms of energy. A reasonable estimate for grain is that about $1\frac{1}{10}$ pounds per 100 pounds live weight is required, which would make a total of 11 pounds of grain daily for a 1,000-pound horse. A reasonable estimate for the amount of roughage is $1\frac{1}{2}$ pounds per 100 pounds live weight, which makes the requirement about 12 pounds of hay daily.

The next step is to list the available feeds; in this case let us assume that shelled corn, oats, alfalfa, and timothy hay are available.

From the list of analyses in the first table we know the composition of each of these feeds. The desired object is to combine the feeds so that the total nutrients will be 1.4 pounds digestible protein and 12.4 therms of energy. The estimated amounts of grain and roughage are merely guides.

We first make a rough estimate of the amount of each feed necessary; then calculate the actual nutriment in the estimated amounts; and, lastly, make reductions, additions, or substitutions to the ration so that the total amount of nutrients will be very near 1.4 pounds of protein and 12.4 therms of energy.

For a trial ration let us take 7 pounds of oats and 4 pounds of corn for concentrates and 6 pounds each of alfalfa hay and timothy hay for roughages. According to the analyses, 100 pounds of oats have 8.7 pounds of true protein and 67.56 therms of energy. In our trial ration we are using 7 pounds of oats, which is $\frac{7}{100}$ of 100 pounds. Multiplying 8.7 and 67.56 by $\frac{7}{100}$, we find that in 7 pounds of oats there are 0.609 of a pound of protein and 4.7292 therms of energy. By similar use of the table we can determine the nutrients in the other feeds used in the estimated ration as follows:

Trial ration for 1,000-pound horse or mule at medium work

Ration	True protein	Energy
	Pounds	*Therms*
7 pounds oats	0.609	4.7292
4 pounds corn	.280	3.4200
6 pounds alfalfa hay	.426	2.0538
6 pounds timothy hay	.132	2.5812
Total	1.447	12.7842
Theoretical requirement	1.4	12.4

The computed ration is satisfactory in filling the theoretical requirements and has a slight margin of surplus. This is close enough for practical purposes.

If, in computing the nutrients in an estimated ration, the amount of protein is found to be low and the amount of net energy is high, there should be substituted a feed comparatively high in protein and low in energy; thus alfalfa hay sometimes may be substituted for timothy, or wheat bran may replace part of the corn in a ration.

It is not satisfactory to depend wholly upon grains and other concentrated feeds for furnishing nutrients to horses; neither will it do to provide only roughage. The horse has a relatively small stomach and can not take care of great quantities of coarse, nonnutritious feed, but there must be sufficient bulk to the ration to make normal the process of digestion. Both concentrates and roughages are necessary.

FEED FOR LIGHT HORSES

In horses of the light breeds that are used for pleasure or racing, the qualities desired are spirit, action, and endurance, and large, paunchy stomachs are objectionable. Such horses require proportionately more grain and less hay than horses doing slow or heavy work. Oats easily rank first among the feeds for light horses; they

may be supplemented with crushed or soaked barley and bran. Corn is too fattening to constitute the bulk of the concentrates for light horses; it may be used, however, if supplemented with linseed meal or bran. A mixture of one of the legume hays, as alfalfa or clover, fed with timothy or other hay, will furnish the roughage. A larger quantity of hay should be allowed for horses less actively employed and should be fed mostly at night. One pound of hay and 1 to 1¼ pounds of grain per 100 pounds live weight will be sufficient for such light horses at moderate work.

FEEDING WORK HORSES

The quantity of feed for the work horse depends on the amount of work done and on the speed at which it is performed; a horse requires considerably more feed when working at the trot than at the walk. As before stated, it is a good rule to allow 1⅛ pounds of grain and 1½ pounds of hay per 100 pounds live weight for horses at moderate work. At this rate a 1,200-pound horse would require 13 pounds of grain and about 14½ pounds of hay per day. If the work is severe, the quantity of grain should be increased. The horse at very hard work requires 1¼ to 1½ pounds of grain per 100 pounds live weight; the hay fed, however, should not be over 1¼ pounds per 100 pounds live weight. On idle days during the work season the grain ration should be reduced approximately one-half. The exact quantity to feed at any time will depend largely on the individuality of each horse.

PRINCIPAL FEEDS FOR HORSES

In connection with rations for horses a brief discussion of the merits of the more common feeds will assist in the choice of a ration. The nutrients contained in each feed may be ascertained by consulting the table of analyses. It is the special purpose of the following review to judge the feeds from the standpoint of the horse feeder.

For convenience the feeds will be classified as concentrates, roughages, succulent feeds, and condiments.

CONCENTRATES

Oats.—This grain ranks as one of the very best for horses. The kernel is incased in a hull which, although it has no great nutritive value, greatly improves the physical character of the feed by adding bulk. Oats probably come nearer to filling the requirements of a concentrate for horses than any other grain. Compared with corn, oats have more protein and less carbohydrates. Oats are readily available in almost every part of the country and may be fed either whole or ground. They should be rolled or ground for very young animals.

Some horses eat oats too rapidly. With such ravenous feeders, to prevent the danger of choking, it is advisable to place a little chopped clover hay or some whole corncobs in the feed box with the oats. The use of wheat bran with oats also lessens the tendency toward choking. Oats may form the entire grain ration for horses. The substitution of 2 or 3 pounds of wheat bran improves the daily ration provided it does not produce a too laxative effect.

Corn.—In many sections corn is given preference over oats as a horse feed, as it is generally grown on the average farm or may be obtained easily. Corn may be fed on the cob, shelled, or ground. It is especially rich in carbohydrates; more energy is derived from a pound of corn than from a pound of any other suitable grain. It is considered as an economical part of a ration. Since this grain is somewhat low in protein, it is well to provide leguminous hay for the animals that are fed corn. The combination of alfalfa hay and corn is receiving much favor when fed to horses. In the absence of legumes, a little oil meal or some other protein concentrate may be included in the ration. Corn is fattening, heat producing, and is greatly relished by horses.

It is sometimes claimed that horses which are fed corn are more subject to colic than those fed oats and other grains. Little difficulty in this line, however, is experienced in the Corn Belt, where it is fed constantly. Horses that have not been accustomed to eating corn should not be changed to it suddenly; in fact, all changes in the horse ration should be made gradually. Corn is suited to form the major part of the grain ration for horses if a nitrogenous (protein) roughage is fed in combination with it.

Corn-and-cob meal.—Although the commonest practice in feeding corn to horses is to use ear or shelled corn, in occasional instances this grain is fed in the form of corn-and-cob meal. This form is especially suitable for

animals which do not have the necessary time to chew thoroughly the ear or shelled corn or in case a horse's age or the condition of the teeth makes the feeding of whole grain impracticable. Corn-and-cob meal is of about the same feeding value, pound for pound, as shelled corn, but certain precautions must be taken in feeding it. When stored for a time it has a tendency to generate heat, with the consequent formation of mold. It is therefore best to grind the grain only as needed.

Wheat.—Under ordinary conditions wheat is relatively too high in price to permit its economical use in the horse ration. If conditions permit, however, wheat may be satisfactorily used for horses provided it is crushed or rolled and fed in moderate quantities. Crushing or rolling is necessary because horses can not efficiently chew the whole, hard grains, and a limitation of the amount fed is essential to prevent digestive disturbances. Compared with corn, wheat carries slightly more carbohydrates, more crude protein, but less fat. The most satisfactory feeding results will be obtained when wheat is fed in conjunction with a bulky concentrate and when the roughage is of protein nature, rich in mineral matter, as alfalfa.

Wheat bran.—This is a favorite feed among horsemen because it is especially palatable and safe. A by-product of milling, bran is usually somewhat expensive and is not always readily available. Wheat bran is quite laxative, and for this reason it is especially valuable for pregnant mares, idle horses, and colts. With horses doing irregular work, the movement of the bowels may be regulated by increasing or decreasing the allowance of bran. Because this feed is light and soft in character it makes a good mixture with other feeds, often making them more suitable for feeding. Wheat bran is very nutritious; it is higher in protein than either oats or corn. However, it is not suited to form the entire concentrate ration for horses because it is too bulky and is somewhat deficient in lime.

Barley.—Barley is used as a principal grain for horses in many parts of the West. Except in physical character it is well suited to the horse ration. This grain should be rolled before being fed. If finely ground it will form a pasty mass with the saliva of the mouth. Barley is a little higher in total nutrients than oats, but is not so widely used nor so generally popular a feed among horsemen. Rolled barley is suitable to form the major part of the grain ration for horses.

Rye.—This may be used as a horse feed in combination with other grains. In some regions it is an economical feed. It is even higher in total nutrients than oats. The grain is small and hard and should be rolled or ground. Many horses will refuse whole rye when fed alone, and an abrupt change to rye feeding is liable to produce colic. Most of the charges against rye may be traced to the feeding of moldy or otherwise damaged grain. It is probably better to limit the amount of rye to one-third of the grain ration. It may be mixed with ground corn, bran, oats, or other grains. Rye is not generally considered desirable to form a major part of the grain ration for horses, as it is not palatable when fed alone and is liable to cause digestive disturbances.

Buckwheat.—This grain is not very commonly used as a horse feed, although it is only a little below the more common cereals in total digestible nutrients. It has a characteristic, hard, black hull which has practically no value as a feed. Unadulterated buckwheat middlings are not easily obtained. They are made from that part of the kernel just beneath the woody hull and are very rich in protein. The common practice is to mix the middlings with the woody hulls and sell it as buckwheat feed or buckwheat bran. This product has a lower feeding value than wheat bran. If the proportion of hulls is not too large, buckwheat bran may be well used in the horse ration. Buckwheat should be limited to one-third the grain ration.

Rice.—Rice is considered economical for horse feed in some of the Southern States, the less valuable kind of rough rice being used. This grain is small and extremely hard; it should be ground or rolled before use in the horse ration. It is better to limit rough rice to one-third of the grain allowance. Rice may be used in connection with corn, blackstrap molasses, and a very limited allowance of some protein concentrate, such as cottonseed meal, soy-bean meal, or linseed meal.

Soy beans, cowpeas, velvet beans, horse beans, field peas.—All these are similar seeds of leguminous plants, and are suitable for use in limited amounts in the horse ration. Since all are hard

seeds, they should always be ground. Their proper use in a ration for horses is as a somewhat concentrated protein feed to be combined with feeds high in carbohydrates, such as molasses and corn. Digestive troubles are very liable to occur if one or more of these feeds exceed one-third of the concentrate ration. Used with care they have a very valuable place in horse feeding.

Coconut meal.—A by-product from the manufacture of coconut oil, coconut meal is considered a safe but rather unpalatable feed for horses. It is a little higher in nutrients than wheat bran, but has the disadvantage of becoming rancid after standing a few weeks. To the extent of one-fourth of the grain ration it may replace oats where economy justifies the measure. Coconut meal is not a very heavy protein concentrate.

Peanuts.—In the form of peanut meal this feed is often given to horses. Shelled peanuts are liable to become rancid if stored for any length of time. The commercial form of peanut meal is the ground hull and kernel combined. It is a comparatively safe feed for horses, but is so rich in protein that the allowance should be limited. When it is used, animals should be started on this feed gradually and it should be fed in connection with corn or some other carbonaceous feed.

Linseed meal.—This feed is the ground cake resulting after the oil has been extracted from flaxseed. It is very high in protein, has laxative properties, but is not suited to form the bulk of the grain ration. Linseed meal is quite unpalatable, but is valuable, however, for combining with corn and other carbonaceous feeds, being a heavy protein concentrate. It is most successfully fed with ground feeds or in a mixture containing molasses, for if fed in combination with feeds from which it can be separated readily, horses will eat the palatable grains and refuse the meal. Some feeders use linseed meal as a conditioner, giving a small amount (about one-half pound) three times a week to keep the bowels in free condition. The more favorable results in the use of linseed meal are obtained when the quantity used is limited to 1 pound or less per day for each animal.

Shorts (wheat middlings).—This is not extensively used as a horse feed because it is usually high in price and its heavy nature and high protein content make it unsuitable to form the major part of the ration. It is palatable, however, and may be used to supplement a horse ration that is low in protein. The quantity should be limited to one-fourth of the concentrate allowance.

Cottonseed meal.—The resulting ground cake after the oil has been extracted from the cottonseed is a heavy protein concentrate which, unlike linseed meal, is not laxative in character. This feed has met with considerable disfavor among horse feeders, as it is believed to have a tendency to produce digestive disorders. There is no doubt some foundation for this belief, but it has been found that the harmful results have usually followed either the use of a poor quality of meal or the feeding of too much. Cottonseed meal may be fed to horses in limited quantities if due care is exercised in obtaining bright, choice meal and if the animals are put on the diet gradually. Its proper use is as a supplement to a carbonaceous concentrate, such as corn. Favorable results have been obtained in some parts of the South in the feeding of cottonseed meal in connection with blackstrap molasses and grain. Since the meal is not palatable, it should be well incorporated with other feeds. While cottonseed meal has been fed in large quantities in isolated cases, the best results may be obtained by limiting the amount to 1 pound daily per 1,000 pounds live weight, and giving special attention to the horses being fed.[3]

Alfalfa meal.—Chopped alfalfa is often desirable to improve the physical character of a ration, but feeding alfalfa as a meal is not to be generally recommended. Alfalfa is a very valuable horse feed but is properly classed among the roughages, even though it is higher in nutrients than some of the concentrates. Finely ground alfalfa is dusty and must be dampened before it can be fed with satisfaction. There is no advantage which justifies the additional cost of grinding, except for horses with bad teeth or weak digestive organs.

Millet, kafir, and milo seeds.—These are very small, hard grains which must be ground before they are suitable for the horse ration. They compare favorably with oats in regard to total nutrients, and any of them, when ground or rolled, may be used in combination with other grains, but it is

[3] For further information, refer to U. S. Department of Agriculture Bulletin 929, Cottonseed Meal for Horses. Out of print, but may be consulted in libraries.

well to limit the amount used to one-third the total concentrate allowance. The sorghum grains are high in carbohydrates and tend to cause constipation when fed heavily. These grains, therefore, should be fed in conjunction with a laxative protein feed, such as wheat bran, to counteract this tendency.

Dried brewers' or distillers' grains.—These grains, which are by-products of fermentation industries, are rather heavy protein concentrates and suitable for balancing carbonaceous rations or for incorporation with chopped mixtures, but are not suitable for use as the major part of the grain ration. They are not palatable and should be limited in amount to about one-fourth the total allowance of concentrates. Some feeders claim that these feeds have a tendency to cause constipation.

Gluten meal.—A by-product of starch manufacture, it is high in protein and fairly high in carbohydrates. It is classed as a protein concentrate, and should be limited to about one-fourth the total grain allowance. It is not very palatable, but sometimes is valuable for use in chopped mixtures.

Gluten feed.—This is also a protein concentrate but is somewhat less nutritious than gluten meal. Gluten feed is made by mixing corn bran with gluten meal, and is not very palatable. The proper use of gluten feed is for balancing more carbonaceous rations, and it should be limited in amount to one-third of the grain ration. Like gluten meal, it may well be used with other grains in a chopped mixture and fed with molasses.

Dried beet pulp.—A by-product of sugar manufacture, this pulp is unpalatable, but by mixing with molasses or other well-liked feeds, it may be included in the ration. It is very low in protein. Dried beet pulp is a safe feed, but it is not desirable to use it in excess of about 5 pounds in the daily ration, and it should be fed in connection with some feed that is relatively high in protein.

Cane molasses (blackstrap molasses).—The use of this feed is quite popular in cane-growing sections. It is high in carbohydrates and should be fed in connection with feeds relatively high in protein. Molasses is especially palatable and is well suited for combination with chopped mixtures containing nutritious but unpalatable feeds. It is usually desirable to dilute it with two parts of water before feeding over grain or roughage. The amount of molasses in the ration should be limited. Usually about 5 pounds daily is a very reasonable allowance, although some feeders use considerably more than that amount. Cane molasses is neither laxative nor binding in effect. Molasses is not usually an economical feed except in sugar-producing regions. However, it is often desirable to use a small amount, such as a quart (3 pounds) a day, as an appetizer.

Beet molasses.—As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain constituents stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate ration that also includes a protein feed.

Milk.—Sometimes milk may be used with good results for feeding horses. Its particular advantage is in its use for colts and for horses that are out of condition. Milk may also be a valuable feed for horses doing very light work. It is palatable, easy to digest, and valuable for fattening. If cow's milk is to be substituted for mare's milk for young colts, there should be an addition of a little sugar and a little limewater. It is not desirable to feed a large quantity of milk to horses generally, but 3 or 4 gallons a day can well be allowed a horse not doing heavy work. Milk is a safe feed, and even in clabbered condition it is not harmful.

Tankage and blood meal.—These by-products of slaughterhouses do not rank high as horse feeds. They are very high in protein, but are extremely unpalatable. They may be used, however, in amounts not exceeding 1 pound each day per animal in connection with some palatable carbonaceous mixture. Tankage and blood meal are used principally for young stock and for building up animals in extremely poor condition.

ROUGHAGES

Alfalfa hay.—This roughage is receiving very great favor as a horse feed. It contains nearly as much nutriment, pound for pound, as wheat bran. It is very high in protein and minerals; hence it is especially valuable for young stock. Alfalfa is somewhat laxative in effect. Because of this and its high protein content, it is well to limit the amount to one-half or two-thirds the roughage allowance. Tim-

othy hay may be used to make up the rest of the roughage supply. Alfalfa is especially suited for use with a grain ration that is low in protein. Corn as the grain, and alfalfa as the roughage, equal weights of each, very nearly make a balanced ration. In considering a roughage for horses, it is desirable to furnish one that is relatively high in nutriment, since the horse has a comparatively small stomach and is unsuited to take care of great quantities of nonnutritious material. Alfalfa meets this requirement. Because of its soft stems this roughage is often used in chopped mixtures.

Timothy hay.—This hay is highly recommended for horses. Notwithstanding the fact that it is not very high in nutrients, there is probably no other one form of roughage that is better suited for the horse ration. It is low in protein and is suitable for combination with alfalfa, clover, or some other legume. If timothy is fed as the only form of roughage, the concentrate allowance should be relatively high in protein. Because of its sharp, brittle stems it is not well suited for use in chopped mixtures. It is readily available in most sections of the country. Timothy hay and oats have long been regarded as the standard horse feeds, but the combination can be improved by including some feed that is relatively high in protein.

Clover hay.—This is a good feed for horses. The usual criticism of this hay is that it is often dusty. Dampening at the time of feeding will aid somewhat, but proper care in the curing of the hay is the best means of preventing dust. Bright clover hay that is free from dust is almost as valuable as alfalfa. It is more palatable than timothy, and a mixture of clover and timothy is to be preferred to timothy alone as a roughage for horses. Clover is a legume, high in protein, somewhat laxative in effect, is an excellent feed for colts, and is suited for use in connection with a grain ration that is rather low in protein. Where only one kind of hay is fed, a smaller quantity is required of clover than of timothy. Various kinds of clovers are used for hay in different parts of the country. Common red clover is most widely used. Mammoth or Big English clover is acceptable, but is somewhat coarse. The very coarse, large varieties, such as sweet clover, are usually too woody to be very desirable. Alsike is very good, but the yield of this crop is usually not large enough to encourage its growth in most localities. If hay from crimson clover is to be used as a horse feed, the crop should be cut before the blossoms are ripe, as the hairy growth on the head of the plant becomes wiry and indigestible and forms masses similar to hair balls, in the digestive tract, which often result in serious cases of impaction. Bur clover of the South may be used as a hay for horses, but its use is not common.

Corn stover.—Corn fodder from which the grain has been removed is a common feed for horses. The objections to it are that it is usually so carelessly handled that most of the nourishment is lost, and that the feed is allowed to become partly spoiled. It is also unhandy to feed unless some special preparation is given, and there is usually considerable waste connected with feeding it. However, corn stover that is bright and clean and which retains its leaves is very palatable, desirable, and safe for horses, and is suitable for use as the sole roughage during the fall and early winter. It is low in protein and should be fed in combination with a concentrate ration which will offset the deficiency. Cutting or shredding is usually advisable if it is to be fed in the stable.

Oat hay.—Hays from oats and similar cereals are commonly fed to horses. These crops should be cut before maturity if they are to be used as forage. They are palatable and nourishing, and care should be taken that the amount is limited. On account of the grain, the allowance should be about one-third less than would be fed in the case of the more common roughages. Very little concentrated feed is needed with oat hay, but it is desirable to include a feed relatively high in protein. Cereal hay may be fed as half the roughage allowance in connection with a legume hay. With such a combination only about half the usual grain ration is necessary.

Cowpeas, soy beans, velvet beans, and field peas.—These may be used as hay for horses. All are legumes, high in protein, and suitable for use in connection with concentrates that are high in carbohydrates, such as corn or molasses. The peas and beans are slightly laxative in effect. It is well to limit these feeds to one-half the roughage allowance; timothy or prairie hay may well be used to form the other half. The amount of grain in the pods should be taken into consideration, and the ration of concentrates should be reduced accordingly.

Field-pea vines that have been carefully cured after the peas have been threshed out are fairly acceptable as horse forage. A full grain ration and a little hay should be fed with them. Unthreshed cowpeas, soy beans, velvet beans, and field peas are safe and fairly palatable feeds, but are too concentrated to form the complete roughage allowance.

Millet, or Hungarian hay.—This is suitable for use in the horse ration, provided the crop has been cut before it is too mature and that an excessive quantity is not fed. The small, hard seeds of mature millet are objectionable, as harmful action on the kidneys is claimed when an excess of these is fed. This hay is carbonaceous in character and should be fed in connection with a legume hay, or the concentrate allowance should contain feeds a little high in protein. Bright millet hay of fine growth is quite satisfactory as a horse feed when limited to half the roughage allowance.

Prairie hay.—This hay is satisfactory for use as a horse feed and is commonly used in the West. It is slightly lower in nutrients than timothy hay, is carbonaceous, and should be fed in combination with a legume hay. It is a safe feed, fairly palatable, and may form the total roughage allowance if the concentrate ration is sufficiently high in protein.

Orchard-grass hay.—Orchard grass makes a suitable hay for horses only when it is cut before maturity. It compares very favorably with timothy, and its palatability is not criticized in hay that is not too mature when cut. It is carbonaceous, and when used either the concentrates should be high in protein or a legume hay should form part of the roughage allowance. It is a safe feed for horses.

Johnson-grass hay.—In certain sections of the South, particularly throughout the Cotton Belt States, Johnson grass grows luxuriantly, often producing three cuttings of good hay a year and forming excellent pasturage. In this district this grass may be utilized to advantage as forage for horses. Johnson grass is a carbonaceous roughage which has a feeding value equivalent to timothy, is slightly laxative in character, and is eaten with relish by horses. The principal drawback to feeding Johnson-grass hay in those sections where clean cultivation of other crops is practiced lies in the fact that such feeding distributes the seeds of the plant and makes the confinement of its growth to a limited area very difficult.

Brome grass.—This grass is of carbonaceous character and is common in the North and West. The hay is palatable and safe for horses. It is a little low in protein, and the grain ration that is fed with it should include a protein concentrate.

Straw.—Straw from various cereals such as oats, barley, wheat, rye, and rice, is often used as a feed for horses. It is bulky, nonnutritious, and is not especially suitable, since the horse has a comparatively small stomach and its digestive anatomy is in no way suited to handle a large amount of bulky feed. So very little nourishment is derived from straw that it is not considered a suitable feed for animals doing hard work. Straw is carbonaceous, and its principal use is for idle horses. Some laxative feed should be fed in connection with it. Because of economy, it is often desirable to feed some straw, and in this case the concentrate allowance should be high in protein. A little straw may be included in a ration in which the principal roughage is alfalfa, clover, or some other legume. Oat straw is preferable; barley straw and wheat straw are good; straw from buckwheat or rye is not desirable; straw from rice is sometimes fed with good results when the remainder of the ration is high in protein. The economy of feeding straw is a factor which can not be disregarded, but the practice should not be carried to the extreme, and care should be taken to supply sufficient protein through the concentrate ration.

Vetch.—This legume is not very commonly used as a horse feed. The plant is rich in nutrients, is suitable to form about half of the roughage allowance in a ration that is lacking in protein, and is fairly palatable. A combination that is meeting with favor is vetch and oat hay.

Sudan grass.—This plant makes a suitable hay for horses and is fairly palatable. As a carbonaceous feed the hay is suitable for use as part of the roughage allowance in combination with a legume hay. Its principal use is in the South.

Bermuda grass.—Hay from this plant is sometimes used in the South. It is a carbonaceous feed, suitable for use in connection with legume hay for the roughage allowance. If fed alone

the concentrate allowance should be high in protein.

Sorghum.—Fodder from sorghum may be used as dry forage for horses but does not keep for a great length of time. It is especially high in carbohydrates, is palatable and suitable for use in connection with feeds which are high in protein.

Pumpkins.—As a succulent feed for horses, pumpkins have a fair value, their feeding value being about two-fifths that of silage, and their main use for improving digestion. The seeds have a laxative effect. It is not advisable to feed pumpkins which have been frosted. They are not usually fed in great amount and should be limited to about 8 pounds daily. No other laxative feed should be included in the same ration, there should be a slight decrease in the amount of roughage, and provision should be made for feeds relatively high in nutrients to balance the ration.

Silage.—Silage should not be considered as one of the principal roughages for horses. Its use is as a succulent, an appetizer, and tonic to be fed in limited quantities as a supplement to the regular ration, preferably for idle horses. When used, this feed must be introduced gradually into the ration. It is a very dangerous practice to feed moldy or frozen silage to horses. Corn silage is the only kind that has met with any degree of favor as a horse feed. It has a valuable place in the winter ration if fed with care. The amount should not exceed 10 pounds daily per animal.

WATER

There is a diversity of opinion among horsemen on the question of watering horses. Some feeders maintain that horses should always be watered before feeding in order to prevent a flushing of the grain through the stomach into the small intestine. This system is not always practicable, however, as some animals will refuse to drink before eating. The consensus of opinion on watering horses indicates that water may be given either before, during, or after meals without injurious effects. Thus, individual convenience and attendant circumstances will largely determine the watering practice to be followed. In any practice, however, it is well to adhere to the same plan, once a definite watering time has been adopted, for to change frequently from one system to another will affect the animal's appetite. Regularity in watering methods as well as feeding methods should be adhered to.

The following factors should be considered in watering horses:

Horses which have been deprived of water for a long period or those which have undergone severe exertion should generally be watered before eating. It is dangerous, however, to allow an animal to drink heavily while very warm. If the horse is hot, give a moderate drink at this time, and water more freely when the animal is cool.

It is not a good practice to water heavily just before putting horses to heavy work.

Weather conditions, the nature of the work done, and the kind of feed consumed will determine the quantity of water required. In hot weather and when at hard work, horses consume more water than in cold weather or when inactive. Horses will drink more water when fed a protein-rich ration, such as alfalfa hay, than when on a carbonaceous diet.

The average water consumption per individual horse is from 10 to 12 gallons daily.

One of the times when a horse requires and appreciates a drink most is when it has finished its nightly allowance of roughage. Every horse should be allowed to drink at this time if possible.

Horses at hard work in hot weather should be watered hourly. It is better to water frequently, in small quantities, than to allow the animal to gorge itself at any one time.

Watering at public troughs is to be avoided, as this is a common method of spreading disease.

SUCCULENT FEEDS

Pasture.—Pasture is foremost among the succulent feeds for horses. It acts as a laxative and general tonic to the system, is an appetizer, and a valuable feed. Succulent feeds are watery and do not produce solid flesh. While pasture alone is sufficient to maintain idle horses, it is well to consider the relative feed value of the pasture crop and the general condition of the pasture. Usually it is advisable to feed a light grain ration relatively high in protein in connection with pasture, even when the horses are idle. Pasture is very valuable in the management of work teams; regularly allowing horses the freedom of pasture during the night and on idle days enhances the health of the animals. There will be an increased tendency

toward sweating while at work but this is not of great importance when the benefits are considered. For work horses that are given pasture, other laxative feeds should be taken out of the ration. Timothy hay may be used as the roughage, and the concentrate allowances should include grains that are not laxative in character, thus making a properly balanced ration. A necessary precaution is to avoid a sudden change to green feed; where a pasture crop is included in the ration for work horses, the pasturing should be continuous, not intermittent.

Soiling crops.—Most of the forage crops previously mentioned under "Roughages" may be cut green and fed to horses. This practice is probably most common with corn. Care should be taken, however, to prevent sudden changes to this type of green feed. There is also danger of the crop's spoiling before being fed; therefore, the green feeds should be used only when fresh. The balancing in regard to nutrients should be the same for soiling crops as for pasture. The pasture system provides exercise and on this account is far preferable to soiling.

Roots.—Carrots, parsnips, rutabagas, and beets are succulent feeds used principally as an aid to digestion. Their use in the horse ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed other laxative feeds should be omitted, the roughage supply should be decreased, and the grain ration should contain feeds high in nutrients. Chopping the roots is usually advisable.

Potatoes.—Potatoes are relatively high in food value, are palatable, and are well suited for use as a horse feed where the cost is not prohibitive. It is safe to feed as high as 15 pounds a day to work horses. They are equivalent to about one-third their weight in hay. When potatoes are fed, a legume hay is a desirable supplement. If a carbonaceous hay is fed, the grain ration should contain feeds rich in protein. Potato sprouts are injurious to horses and should be removed. It is advisable to chop potatoes before feeding, as the danger from choking is thereby lessened.

Fruits.—When without stones, fruits may be used for feed and are much relished by horses. This addition to the ration is as an appetizer and relish rather than as a nutritious feed. Fruits are low in protein, and if used in considerable amount the main ration should be nitrogenous in character. Ten pounds of fruits daily are not harmful.

SALT

Horses should be given salt at frequent, regular intervals, or, better, salt should be accessible at all times. When salt is given regularly, only enough to meet the body requirements will be consumed, while with irregular use an abnormal appetite develops for it, which, in turn, is often followed by an excessive consumption and digestive troubles if unlimited access is allowed. An average of about three-quarters of an ounce daily should be allowed under normal conditions. Horses doing heavy work, however, or those on dry feed will consume more than this quantity.

Aside from its value as a feeding requisite, salt is of benefit as an appetizer, for in many instances delicate eaters and shy drinkers will show an increased appetite when allowed free and regular access to it.

STOCK FEEDS AND CONDIMENTS

The stock and condimental feeds that are generally bought on the market, which are represented to be conditioners, tonics, and fatteners, have for their foundation simple, well-known drugs, and feeds. If a tonic or feed is desired, one of known composition may be mixed at home with entirely satisfactory results. The following formulas are suggested:

I	
Glauber salt	2 pounds.
Soda	1 pound.
Salt	1 pound.
Fenugreek	2 ounces.
Linseed meal	25 pounds.

II	
Glauber salt	5 pounds.
Saltpeter	1½ pounds.
Fenugreek	1 pound.
Gentian	2 pounds.
Linseed meal	50 pounds.

A heaping tablespoonful of one of the foregoing mixtures fed with the grain three times a day is sufficient.

When a tonic is needed it is advisable to investigate why it is needed. The horse should receive daily attention regarding feed, water, salt, exercise, grooming, sanitation, and comfortable quarters. Neglect of any of these factors is usually an underlying cause of the poor condition of an animal.

SUGGESTED DAILY RATIONS

The following daily rations have been prepared with a view of suggesting combinations of feeds that will suit conditions in various parts of the country, and from which the feeder may derive rations that will meet his local needs. Attention is invited to the fact that the rations suggested are for a horse weighing 1,000 pounds, and modification of these rations should be made for heavier or lighter horses. For example, in order to meet the requirements for a horse weighing 1,250 pounds the rations suggested should be increased in accordance with the increase in weight, which in this case is 25 per cent. Roughly this would give the feed requirement for the heavier horse.

Maintenance rations for 1,000-pound idle horse

[Theoretical daily requirement, 0.60 pound of protein and 7.30 therms of energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
5 pounds ear corn	0.280	3.420	4 pounds rolled barley	0.332	3.5976
3 pounds alfalfa hay	.213	1.0269	4 pounds alfalfa hay	.284	1.3692
9 pounds corn stover	.144	2.8458	7 pounds barley straw	.042	2.5627
	.637	7.2927		.658	7.5295
4 pounds oats	.348	2.7024	4 pounds alfalfa hay	.284	1.3692
4 pounds clover hay	.196	1.5472	14 pounds corn fodder with ears	.322	6.1516
10 pounds oat straw	.08	3.481		.606	7.5208
	.624	7.7306	2 pounds shelled corn	.140	1.710
8 pounds alfalfa	.568	2.7384	4 pounds oat hay	.156	1.290
8 pounds oat straw	.664	2.7848	10 pounds orchard-grass hay	.330	4.493
3 pounds cane molasses	.000	1.6614		.626	7.493
	.632	7.1846	3½ pounds shelled corn	.245	2.9925
5 pounds cowpea hay	.460	1.8795	3 pounds cowpea hay	.276	1.127
5 pounds silage (corn)	.030	.7950	10 pounds oat straw	.08	3.481
10 pounds timothy hay	.220	4.3020		.601	7.60
	.710	6.9765			

Daily rations for 1,000-pound horse, very light work

[Theoretical requirement, 1 pound protein and 9.80 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
10 pounds ear corn	0.56	6.840	5 pounds shelled corn	0.35	4.275
5 pounds alfalfa hay	.355	1.711	2 pounds cowpeas	.338	1.5892
5 pounds timothy hay	.110	2.151	½ pound cottonseed meal [1]	.177	.4672
	1.025	10.702	5 pounds corn stover	.08	1.581
8 pounds oats	.696	5.4048	5 pounds sorghum fodder	.075	1.610
4 pounds alfalfa hay	.284	1.3692		1.020	9.5224
6 pounds timothy hay	.132	2.5812	7 pounds shelled corn	.490	5.985
	1.112	9.3552	1 pound cottonseed meal	.354	.9346
5 pounds cowpeas (coarsely ground)	.845	3.9730	4 pounds cowpea hay	.368	1.5036
5 pounds molasses	.000	2.7690	6 pounds corn stover	.096	1.8972
10 pounds oat straw	.080	3.481		1.308	10.3204
	.925	10.223	8 pounds shelled corn	.560	6.840
8 pounds rolled barley	.664	7.1952	4 pounds cowpea hay	.368	1.5036
4 pounds alfalfa	.284	1.3692	6 pounds corn stover	.096	1.8972
5 pounds prairie hay	.145	2.021		1.024	10.2408
	1.093	10.5854			

[1] The meal may be replaced by 1 pound of cowpeas.

Daily rations for 1,000-pound horse at medium work

[Theoretical requirement, 1.40 pounds protein and 12.40 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
13 pounds ear corn	0.728	8.892	11 pounds shelled corn	0.770	9.405
6 pounds alfalfa hay	.426	2.0538	6 pounds cowpea hay	.552	2.2554
7 pounds timothy hay	.154	3.0114	6 pounds corn stover	.096	1.8972
	1.308	13.9572		1.418	13.5576
12 pounds oats	1.044	8.1072	5 pounds cowpea hay	.460	1.8795
1 pound cowpeas (cracked)	.169	.7946	9 pounds corn stover	.144	2.8458
11 pounds timothy	.242	4.7322	10 pounds shelled corn	.700	8.550
	1.455	13.6340	½ pound cottonseed meal	.177	.4673
				1.481	13.7426
10 pounds rolled barley	.83	8.9940			
6 pounds alfalfa hay	.426	2.0538			
5 pounds prairie hay	.165	2.021			
	1.421	13.0688			

Daily rations for 1,000-pound horse at severe work

[Theoretical requirement, 2 pounds protein and 16 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
12 pounds oats	1.044	8.1072	10 pounds rolled barley	0.830	8.9940
2 pounds bran	.216	1.0600	2 pounds gluten meal	.562	1.6830
8 pounds timothy hay	.176	3.4416	8 pounds alfalfa	.568	2.7384
5 pounds clover hay	.245	1.9340	6 pounds prairie hay	.174	2.4252
	1.681	14.5428		2.134	15.8406
12 pounds shelled corn	.840	10.260	5 pounds cowpea hay	.460	1.8795
1 pound soy beans (ground)	.273	.8129	9 pounds corn stover	.144	2.8458
12 pounds alfalfa	.852	4.1076	13 pounds shelled corn	.910	11.115
4 pounds corn stover	.084	1.2648	1½ pounds cottonseed meal	.531	1.4019
	2.049	16.4453		2.045	17.2422
7 pounds peanuts (ground with hull)	1.183	5.8205			
7 pounds cane molasses	.000	3.8766			
7 pounds pea hay	.644	2.6313			
7 pounds timothy hay	.154	3.0114			
	1.981	15.3398			

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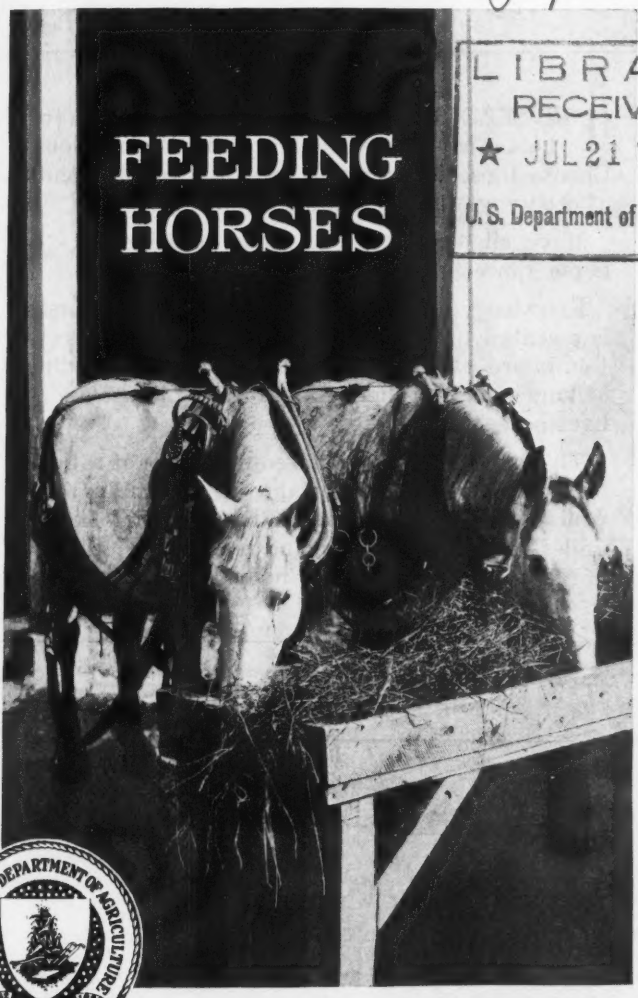
FEEDING HORSES



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UNITED STATES DEPARTMENT OF AGRICULTURE

THE SELECTION of the most suitable ration for horses is governed largely by local conditions. Choose those feeds which meet the requirements of economy, nutrition, and convenience.

Make slight changes in feeds occasionally. A horse appreciates a variety in his diet.

Knowledge of individual requirements of horses is essential to obtain best results. Close observation is probably a more vital factor in the feeding of horses than in the feeding of any other class of livestock.

This bulletin explains the computation of rations for horses, suggests certain feed combinations which approximately meet the needs of horses under varying conditions, and reviews such factors of feeding as tend to make the horse more efficient.

Washington, D. C.

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FEEDING HORSES

By G. A. BELL, formerly *senior animal husbandman*,[1] and J. O. WILLIAMS, *associate animal husbandman, Animal Husbandry Division, Bureau of Animal Industry*

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STUDY OF RATIONS NECESSARY

The computation of rations is valuable as a guide to the feeder in determining suitable combinations which may be obtained from a large variety of feeds. It is useful, also, in determining the requisite amounts of the various nutrients, so that each will be supplied without waste. Results in feeding a ration should be observed and the ration modified according to the specific needs of the animals.

There is far more economy in supplying the required amounts of nutrients in the right proportions than in providing an excess of one and a deficiency of another. Proper attention given to the matter of balancing horse rations will result in benefit to both the health and the working efficiency of the animals fed, which in turn will effect a material reduction in the annual feed bill.

LOCAL INFLUENCES IMPORTANT

No one feed or combination of feeds will meet conditions in all parts of the country. Generally speaking, combinations of home-grown or locally raised crops constitute the most economical rations. Choose from the feeds available those which will most closely meet the requirements of economy, nutrition, and convenience. Substitution may often be made in rations in such a manner that, while the efficiency remains unchanged, the cost is materially lowered. Selection of the most economical and suitable ration is governed largely by local conditions.

CONDITIONS AFFECTING FEED REQUIREMENTS

The kinds of feed used, the quantity required per animal, and the manner of feeding depend on the age, size, and condition of the horse, the amount, kind, and speed of the work done, and the individual fed.

The horse at work usually requires more and richer feed than the idle one. To furnish energy for work, the feed allowance must be in excess of that needed for body maintenance. The amount of feed needed for maintenance is about two-thirds that required for a horse at moderate work. If the work done calls for more energy than is furnished in the ration, the stored-up energy of the body fat or other tissues will be drawn on, with a consequent loss in body weight and energy. Moreover, if such feeding practice is continued, the horse will be so weakened constitutionally that he will be unable to perform his work profitably

[1] Mr. Bell resigned from the Department Oct. 15, 1920.

and also will be especially susceptible to disease.

Horses of the same type and weight may have different feed requirements, which makes it necessary to study the individuality of the animals. If the horse is not doing well on a ration, a slight change should be made. Any change, however, should be made gradually in order to avoid digestive disturbances.

SELECTING A RATION

As no feed or combination of feeds will meet conditions in all parts of the country, so no feed or mixture of feeds is suitable for all classes of horses. In choosing a ration for a horse, select the one that seems to meet best his requirements, whether for growth, maintenance, work, breeding, or fattening; estimate the amount of feed needed, and try out the ration. It may appear after a trial that too little is being fed or that the ration may be changed somewhat in the interest of either economy or efficiency. If a number of horses are kept, different rations may be tested on different animals and the best one selected for general use. Individual feeding gives the best results.

PREPARATION OF FEEDS

The advisability of chopping, cutting, or chaffing hay for horse feeding depends largely on the cost of preparation, the quality of the feed, and its price. Ordinarily, low-priced hay of good quality should not be prepared for feeding, but it may be economical to chop, cut, or chaff poor-quality hay, as it is eaten with less waste than the unprepared forage.

Such roughages as corn stover and sorghum can generally be fed to horses most satisfactorily when shredded or cut. Preparation makes the feed much easier to handle in the stable and results in a greater proportionate consumption of the roughage.

The benefits derived from grinding or crushing oats and corn for horses depend on the cost of preparation, working conditions, and the condition of the animals' teeth. Throughout the Corn Belt corn is usually fed on the cob or in the shelled form, and it ordinarily does not pay to grind it for horses unless the animals' teeth are in poor condition or if there is not time enough for proper mastication of the grain. All small, hard grains, such as rye, barley, rice, and wheat, should be crushed or rolled before feeding, to avoid digestive disturbances, since horses can not properly masticate those grains.

Ordinarily it is not advisable to cook, steam, or soak feeds for horses, since those methods of preparation do not materially improve digestion. When, however, the small, hard grains can not be rolled or crushed, it is a good plan to soak them. It is the accepted practice, moreover, of many horsemen to feed a warm mash occasionally as a tonic and to regulate the bowels.

BALANCING A RATION

Feeding stuffs are broadly divided into two general classes, protein and carbohydrate. The protein feeds are rich in nitrogenous compounds which are used by the animal body in building tissue, bone, hair, etc., and to provide energy. The carbohydrate feeds are starchy in nature and are used by the animal body in the formation of fat and for energy and heat.

To obtain the best results in feeding, the ration should be so balanced that it properly meets the needs of the animal in building tissue and in supplying energy for work. In order to do this, feeds containing the nutrients which supply the required proteins and energy are needed in certain proportions to meet the body requirements. If feeds deficient in protein are fed an excessive amount of carbonaceous nutrients must be consumed in order that the system may obtain the required quantity of protein, and vice versa, and so a waste of feed will be the result. It is essential, therefore, that a balanced ration be fed, that is, one containing proteins and carbohydrates in such proportions that the requisite amounts of each will be utilized without waste.

Feeds rich in protein are usually the most expensive. If more protein is supplied than is needed for nutrition, the cost of the feed is unnecessarily increased. It is more economical to supply the energy necessary to perform work in the form of carbohydrates than proteins. Thus for mature horses at work and for maintaining idle horses the protein feed allowance may be limited to the amount necessary to build tissue, and a large proportion of carbohydrates may be fed.

FEEDING HINTS

The grain part of the ration for horses at work is usually divided into three equal feeds. If the horse does

not clean up grain in a reasonable length of time, the quantity should be reduced. About two-thirds of the daily hay allowance is given at night, with most of the remainder fed in the morning, leaving only a very small allowance for the noon feed. The quantity of roughage should be limited within the maximum allowance, so that all the edible forage will be cleaned up every day. When there is forage remaining from the night feeding, do not put in a fresh supply, but stir up that which is in the manger, so that the chaff goes to the bottom, leaving the good hay available. Some hay should be fed before the grain at night, for the appetite of the horse is not appeased by the grain when it is fed first, and it fills up on hay, forcing the grain on through the stomach too quickly, thereby decreasing the quantity assimilated.

The method of feeding has a great deal to do with the utilization of the feed and the condition of the horse. It is important that the horse that bolts grain be made to eat slowly, which may be done by feeding the grain spread out in a large, flat box, by placing several smooth stones about 3 inches in diameter in the feed box, or by mixing it with bran, cut hay, or similar feed. Some horses waste their hay by pulling it out and trampling it under foot. This is sometimes caused by feeding two kinds of hay, one of which is especially palatable. In that case, the waste may be corrected by feeding the hay so that the horse can eat the more palatable first. The horse will then eat the other hay leisurely during the night. Another plan is to withhold the good hay until the other is eaten.

Overfeeding, rather than underfeeding, is the common practice when horses are working irregularly. It should be remembered that the amount of feed should vary, not only between winter and summer but also from day to day. It is a waste of feed if the amount is not varied with the degree of work.

FEEDING IDLE HORSES

Maintaining the farm work horse in healthful condition during the winter is the first start in fitting it for spring work. The horse should not be so fed during the winter that it becomes fat and soft. Moreover it is bad management to let a horse lose weight during the winter and then try to bring it back to normal by heavy feeding just before the beginning of spring work.

The liberal use of roughage, supplemented with the right quantity and kind of other nutritious feed, will maintain a horse properly during the winter. Farm horses, except brood mares or growing stock, do well on a ration made up largely of the coarser hays, straw, or corn fodder. Cornstalk fields, grain-stubble fields, or pastures which have not been too closely grazed during the summer are very desirable sources of a large part of the winter maintenance feed. The common roughages, as the main part of the ration during this period, will supply bulky feed enough to keep the horse thrifty without putting on superfluous fat. The drinking of a large quantity of pure water should be encouraged to increase the utilization of these dry roughages. When necessary, a tank heater should be used to keep the drinking trough free from ice.

It is advisable to supplement the coarser roughages with a legume, such as alfalfa, clover, vetch, soy-bean, or cowpea hay. These hays are very palatable and should be fed sparingly. They are rich in protein and mineral matter and supply the materials needed to replace those lost in the natural wear of the body. Being somewhat laxative in effect they also help to keep the digestive tract in good condition. They are especially valuable in connection with straw and similar feed. The use of these hays with the coarser roughages is economical because a supplemental ration of grain is not ordinarily necessary.

In some instances, especially when it is not possible to feed a legume hay, a small quantity of grain is necessary to maintain the horses in thrifty condition. Oats are preferred for use with coarser roughages, but corn and barley are often used in the winter ration, especially when they are cheaper or when an increase in weight is desired. One or two bran mashes a week or a little linseed meal each day is recommended as an aid in keeping the system in good condition and in preventing impaction resulting from the use of large quantities of coarse roughage improperly supplemented.

Pregnant mares require more attention during the winter than the open mare or gelding. Leguminous feeds high in protein and ash are necessary in developing the fetus. Although the feeding of legume hay is usually of more importance than a supplemental grain feed, in most cases such feeds as oats, bran, and oil meal should be supplied, the proportions being largely controlled

by the condition of the mare and the stage of development of the fetus.

THE COMPUTATION OF RATIONS[2]

The computation of rations is not difficult, and a little time spent on calculations enables the feeder to provide, from available feeds, a ration which will approximately supply the requisite amounts of protein and carbohydrates. Data on rations will afford valuable aid to the feeder, but he must observe results and modify his feeding accordingly.

The rations given in this publication are based on the true protein and the net energy values of various feeding stuffs. The net energy value is the measure of the true value of the feed as a source of energy to the animal organism after deducting the losses in the unburned materials in the excreta and the energy expended in extracting the real fuel materials from the feed consumed. For example, while 100 pounds of corn meal contain about 187 therms of chemical energy, only about 85 therms remain, after the above-mentioned deductions have been made, to represent the actual value of the meal as a source of energy to the animal.

The following table is adapted from a similar one published in Department Bulletin 459, and gives the true protein and net energy values per 100 pounds of feeding stuffs for ruminants. It may be regarded as expressing with sufficient accuracy the relative value of feeding stuffs for horses. A column has been added designating the group in which some of the common feeds are ordinarily classified. This is done in order to simplify the selection of feeds for compounding a ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
DRIED ROUGHAGE				
Hay and fodder from cereals		*Pounds*	*Pounds*	*Therms*
Brome grass, smooth	Carbohydrate	91.5	3.5	40.83
Corn (maize) fodder (ears included, medium dry)	do	81.7	2.3	43.94
Corn (maize) stover (ears removed, medium dry)	do	81.0	1.6	31.62
Kafir fodder, high in water	do	71.7	1.8	34.28
Kafir stover, high in water	do	72.7	1.0	27.65
Millet, Hungarian	do	85.7	3.9	46.96
Timothy and clover mixed		87.8	3.6	40.85
Oat hay	Carbohydrate	88.0	3.9	32.25
Orchard grass	do	88.4	3.3	44.93
Prairie hay	do	93.5	2.9	40.42
Red top	do	90.2	3.9	51.22
Sorghum fodder, computed to 80 per cent dry matter	do	80.0	1.5	32.30
Timothy, all analyses	do	88.4	2.2	43.02
Hay and fodder from legumes				
Alfalfa, all analyses	Protein	91.4	7.1	34.23
Clover, alsike	do	87.7	5.3	34.42
Clover, crimson	do	89.4	6.9	36.21
Clover, red, all analyses	do	87.1	4.9	38.68
Clover, sweet white	do	91.4	6.7	39.98
Cowpeas, all analyses	do	90.3	9.2	37.59
Soy beans	do	91.4	8.8	44.03
Straws				
Barley	Carbohydrate	85.8	.6	36.61
Buckwheat	do	90.1	3.2	4.55
Oat	do	88.5	.8	34.81
Rice	do	92.5	.4	23.63
Rye	do	92.9	.5	17.59
Wheat	do	91.6	.3	7.22

[2] For detailed information, consult U. S. Department of Agriculture Bulletin 459, The Use of Energy Values in the Computation of Rations for Farm Animals. Out of print, but may be consulted in libraries.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
FRESH GREEN ROUGHAGE				
Green cereals, etc.		*Pounds*	*Pounds*	*Therms*
Barley fodder		23.2	2.0	14.08
Bluegrass, Kentucky, before heading		23.8	2.8	14.82
Bluegrass, Kentucky, headed out		36.4	2.2	17.77
Bluegrass, Kentucky, after bloom		43.6	1.6	21.01
Buckwheat, Japanese		36.6	1.5	17.78
Cabbage		8.9	1.3	8.87
Corn (maize) fodder, dent, all analyses		23.1	.8	14.60
Corn (maize) fodder, flint, all analyses		20.7	.8	13.53
Corn (maize) fodder, sweet, roasting ears or later		20.3	.9	13.38
Corn (maize) fodder, sweet, ears removed		21.5	.8	14.26
Millet, Hungarian		27.6	1.1	17.24
Oat fodder		26.1	2.0	14.06
Orchard grass		29.2	1.1	15.81
Rape		16.7	1.7	13.07
Rye fodder		21.3	1.4	15.99
Sorgo fodder		24.9	.4	15.37
Timothy, before bloom		24.2	1.1	18.36
Timothy, in bloom		32.1	.8	18.89
Timothy, in seed		46.4	1.0	26.36
Wheat fodder		27.4	1.9	18.75
Green legumes [1]				
Alfalfa, before bloom		19.9	1.9	9.20
Alfalfa, in bloom		25.9	1.8	11.50
Alfalfa, after bloom		29.8	1.3	11.10
Clover, alsike		24.3	1.5	14.56
Clover, crimson		17.4	1.6	10.83
Clover, red, all analyses		26.2	1.7	15.87
Clover, red, in bloom		27.5	1.8	16.74
Clover, red, rowen		34.4	2.2	17.30
Cowpeas		16.3	1.7	10.42
Peas, Canada field		16.6	2.1	9.78
Soy beans, all analyses		23.6	2.4	12.53
Vetch, hairy		18.1	2.4	11.95
SILAGE [1]				
Corn (maize), well-matured, recent analysis		26.3	.6	15.90
Corn (maize), immature		21.0	.4	11.96
Corn (maize), from field-cured stover		19.6	.3	8.98
Clover		27.8	.8	7.26
Cowpeas		22.0	1.1	11.05
Soy beans		27.1	1.5	11.59
Sugar-beet pulp		10.0	.5	9.32
ROOTS, TUBERS, AND FRUITS [1]				
Apples		18.2	.1	15.92
Beets, common		13.0	.1	7.84
Beets, sugar		16.4	.4	11.20
Carrots		11.7	.5	9.21
Mangels		9.4	.1	5.68
Potatoes		21.2	.1	18.27
Pumpkins, field		8.3	.6	6.05
Rutabagas		10.9	.3	8.46
Turnips		9.5	.4	6.16
GRAINS				
Cereal grains				
Barley	Protein	90.7	8.3	89.94
Buckwheat	do	87.9	7.2	59.73
Corn (maize), dent	Carbohydrate	89.5	7.0	85.50
Corn (maize), flint	do	87.8	7.2	84.00
Corn (maize) and cob meal	do	89.6	5.7	75.80
Corn (maize) meal	do	88.7	6.4	85.20
Oats	Protein	90.8	8.7	67.56
Oatmeal	do	92.1	11.5	86.20
Rice, rough	Carbohydrate	90.4	4.5	77.33
Rye	Protein	90.6	9.0	93.71
Sorghum grain	Carbohydrate	87.3	6.7	89.75
Wheat, winter	Protein	89.1	7.7	91.66
Wheat, spring	do	89.9	8.1	91.41

[1] These succulent feeds are not usually classed in the two great groups of feeds, as their use is supplementary to the principal ration.

Classification, composition, and net energy values per 100 pounds of feeding stuffs for ruminants—Continued

Kind of feed	Class	Composition		Net energy value
		Dry matter	Digestible true protein	
GRAINS—continued				
Leguminous seeds		*Pounds*	*Pounds*	*Therms*
Beans, navy	Protein	86.6	16.4	73.29
Cowpeas	do	88.4	16.9	79.46
Peas, field	do	90.8	16.6	78.72
Pea meal	do	89.1	17.2	77.62
Peanuts with hull	do	93.5	16.9	83.15
Peanut kernel	do	94.0	22.2	109.04
Soy beans	do	90.1	27.3	81.29
Oil seeds				
Cottonseed	Protein	90.6	11.9	78.33
Flaxseed	do	90.8	19.2	83.17
Sunflower seed	do	95.5	20.2	95.77
Sunflower seed with hulls	do	93.1	11.7	92.49
DAIRY PRODUCTS				
Buttermilk	Protein	9.4	3.4	13.32
Cow's milk	do	13.6	3.3	29.01
Skim milk—centrifugal	do	9.9	3.6	14.31
Skim milk—gravity	do	9.6	3.1	15.43
Skim milk—dried	do	91.7	34.4	103.91
Whey	Carbohydrate	6.6	.8	10.39
Milling				
Buckwheat bran	Protein	88.8	9.1	30.59
Buckwheat hulls	Carbohydrate	89.7		−7.69
Buckwheat middlings	Protein	88.0	20.8	72.19
Hominy feed	Carbohydrate	89.9	6.5	88.78
Red-dog flour	Protein	88.9	13.2	78.80
Rice bran, high-grade	Carbohydrate	89.9	7.0	45.29
Rice meal	do	90.5	6.4	65.24
Rice polish	do	90.0	7.1	77.70
Rye bran	Protein	88.6	10.5	79.35
Wheat bran	do	89.9	10.8	53.00
Wheat middlings, flour	do	89.3	14.0	75.02
Wheat middlings, standard	do	89.6	12.0	59.10
Oil extraction				
Coconut meal, low in fat	Protein	90.4	18.3	83.49
Coconut meal, high in fat	do	92.3	18.0	100.31
Cottonseed hulls	Carbohydrate	90.3		9.92
Cottonseed meal, choice	Protein	92.5	35.4	93.46
Cottonseed meal, prime	do	92.2	32.0	90.00
Linseed meal, new process	do	90.4	30.9	85.12
Linseed meal, old process	do	90.9	28.5	88.91
Peanut cake from hulled nuts	do	89.3	41.4	93.55
Peanut cake, hulls included	do	94.4	19.5	42.57
Soy-bean meal, fat extracted	do	88.2	37.3	99.65
Sunflower-seed cake	do	90.0	29.1	88.87
Starch manufacturing				
Gluten feed	Protein	91.3	20.1	80.72
Gluten meal	do	90.9	28.1	84.15
Starch feed, dry	Carbohydrate	90.9	9.2	77.46
Starch feed, wet	do	33.4	3.7	30.45
Sugar manufacture				
Molasses, beet	Carbohydrate	74.7		57.10
Molasses, cane or blackstrap	do	74.2		55.38
Molasses beet pulp	do	92.4	3.5	76.28
Sugar-beet pulp, dried	do	91.8	.7	75.87
Sugar-beet pulp, ensiled	do	10.0	.5	9.32
Sugar-beet pulp, wet	do	9.3	.5	8.99
Packing house				
Dried blood	Protein	90.3	68.6	68.12
Tankage:				
Over 60 per cent protein	do	92.6	55.6	93.04
55–60 per cent protein	do	92.5	51.1	83.66
45–55 per cent protein	do	92.5	45.5	72.98
Below 45 per cent protein	do	93.5	35.6	54.14

REQUIREMENTS FOR WORK

Rations containing the following amounts of digestible protein and of net energy value may be used as a guide in computing daily rations for the 1,000-pound work horse under varying conditions:

Kind of work	Digestible protein	Net energy value
	Pounds	*Therms*
For light work	1.0	9.80
For medium work	1.4	12.40
For heavy work	2.0	16.00

(Dry matter: For the 1,000-pound horse, from 16 to 25 pounds is a fair average, depending on the amount of work performed.)

METHOD OF COMPUTING RATIONS

Following is an example in computing a ration that will meet approximately the needs of a 1,000-pound horse or mule at medium work:

From the table above we know the requirement to be 1.4 pounds digestible protein and 12.4 therms of energy. A reasonable estimate for grain is that about $1\frac{1}{6}$ pounds per 100 pounds live weight is required, which would make a total of 11 pounds of grain daily for a 1,000-pound horse. A reasonable estimate for the amount of roughage is $1\frac{1}{2}$ pounds per 100 pounds live weight, which makes the requirement about 12 pounds of hay daily.

The next step is to list the available feeds; in this case let us assume that shelled corn, oats, alfalfa, and timothy hay are available.

From the list of analyses in the first table we know the composition of each of these feeds. The desired object is to combine the feeds so that the total nutrients will be 1.4 pounds digestible protein and 12.4 therms of energy. The estimated amounts of grain and roughage are merely guides.

We first make a rough estimate of the amount of each feed necessary; then calculate the actual nutriment in the estimated amounts; and, lastly, make reductions, additions, or substitutions to the ration so that the total amount of nutrients will be very near 1.4 pounds of protein and 12.4 therms of energy.

For a trial ration let us take 7 pounds of oats and 4 pounds of corn for concentrates and 6 pounds each of alfalfa hay and timothy hay for roughages. According to the analyses, 100 pounds of oats have 8.7 pounds of true protein and 67.56 therms of energy. In our trial ration we are using 7 pounds of oats, which is $\frac{7}{100}$ of 100 pounds. Multiplying 8.7 and 67.56 by $\frac{7}{100}$, we find that in 7 pounds of oats there are 0.609 of a pound of protein and 4.7292 therms of energy. By similar use of the table we can determine the nutrients in the other feeds used in the estimated ration as follows:

Trial ration for 1,000-pound horse or mule at medium work

Ration	True protein	Energy
	Pounds	*Therms*
7 pounds oats	0.609	4.7292
4 pounds corn	.280	3.4200
6 pounds alfalfa hay	.426	2.0538
6 pounds timothy hay	.132	2.5812
Total	1.447	12.7842
Theoretical requirement	1.4	12.4

The computed ration is satisfactory in filling the theoretical requirements and has a slight margin of surplus. This is close enough for practical purposes.

If, in computing the nutrients in an estimated ration, the amount of protein is found to be low and the amount of net energy is high, there should be substituted a feed comparatively high in protein and low in energy; thus alfalfa hay sometimes may be substituted for timothy, or wheat bran may replace part of the corn in a ration.

It is not satisfactory to depend wholly upon grains and other concentrated feeds for furnishing nutrients to horses; neither will it do to provide only roughage. The horse has a relatively small stomach and can not take care of great quantities of coarse, nonnutritious feed, but there must be sufficient bulk to the ration to make normal the process of digestion. Both concentrates and roughages are necessary.

FEED FOR LIGHT HORSES

In horses of the light breeds that are used for pleasure or racing, the qualities desired are spirit, action, and endurance, and large, paunchy stomachs are objectionable. Such horses require proportionately more grain and less hay than horses doing slow or heavy work. Oats easily rank first among the feeds for light horses; they

may be supplemented with crushed or soaked barley and bran. Corn is too fattening to constitute the bulk of the concentrates for light horses; it may be used, however, if supplemented with linseed meal or bran. A mixture of one of the legume hays, as alfalfa or clover, fed with timothy or other hay, will furnish the roughage. A larger quantity of hay should be allowed for horses less actively employed and should be fed mostly at night. One pound of hay and 1 to 1¼ pounds of grain per 100 pounds live weight will be sufficient for such light horses at moderate work.

FEEDING WORK HORSES

The quantity of feed for the work horse depends on the amount of work done and on the speed at which it is performed; a horse requires considerably more feed when working at the trot than at the walk. As before stated, it is a good rule to allow 1⅕ pounds of grain and 1½ pounds of hay per 100 pounds live weight for horses at moderate work. At this rate a 1,200-pound horse would require 13 pounds of grain and about 14½ pounds of hay per day. If the work is severe, the quantity of grain should be increased. The horse at very hard work requires 1¼ to 1⅓ pounds of grain per 100 pounds live weight; the hay fed, however, should not be over 1¼ pounds per 100 pounds live weight. On idle days during the work season the grain ration should be reduced approximately one-half. The exact quantity to feed at any time will depend largely on the individuality of each horse.

PRINCIPAL FEEDS FOR HORSES

In connection with rations for horses a brief discussion of the merits of the more common feeds will assist in the choice of a ration. The nutrients contained in each feed may be ascertained by consulting the table of analyses. It is the special purpose of the following review to judge the feeds from the standpoint of the horse feeder.

For convenience the feeds will be classified as concentrates, roughages, succulent feeds, and condiments.

CONCENTRATES

Oats.—This grain ranks as one of the very best for horses. The kernel is incased in a hull which, although it has no great nutritive value, greatly improves the physical character of the feed by adding bulk. Oats probably come nearer to filling the requirements of a concentrate for horses than any other grain. Compared with corn, oats have more protein and less carbohydrates. Oats are readily available in almost every part of the country and may be fed either whole or ground. They should be rolled or ground for very young animals.

Some horses eat oats too rapidly. With such ravenous feeders, to prevent the danger of choking, it is advisable to place a little chopped clover hay or some whole corncobs in the feed box with the oats. The use of wheat bran with oats also lessens the tendency toward choking. Oats may form the entire grain ration for horses. The substitution of 2 or 3 pounds of wheat bran improves the daily ration provided it does not produce a too laxative effect.

Corn.—In many sections corn is given preference over oats as a horse feed, as it is generally grown on the average farm or may be obtained easily. Corn may be fed on the cob, shelled, or ground. It is especially rich in carbohydrates; more energy is derived from a pound of corn than from a pound of any other suitable grain. It is considered as an economical part of a ration. Since this grain is somewhat low in protein, it is well to provide leguminous hay for the animals that are fed corn. The combination of alfalfa hay and corn is receiving much favor when fed to horses. In the absence of legumes, a little oil meal or some other protein concentrate may be included in the ration. Corn is fattening, heat producing, and is greatly relished by horses.

It is sometimes claimed that horses which are fed corn are more subject to colic than those fed oats and other grains. Little difficulty in this line, however, is experienced in the Corn Belt, where it is fed constantly. Horses that have not been accustomed to eating corn should not be changed to it suddenly; in fact, all changes in the horse ration should be made gradually. Corn is suited to form the major part of the grain ration for horses if a nitrogenous (protein) roughage is fed in combination with it.

Corn-and-cob meal.—Although the commonest practice in feeding corn to horses is to use ear or shelled corn, in occasional instances this grain is fed in the form of corn-and-cob meal. This form is especially suitable for

animals which do not have the necessary time to chew thoroughly the ear or shelled corn or in case a horse's age or the condition of the teeth makes the feeding of whole grain impracticable. Corn-and-cob meal is of about the same feeding value, pound for pound, as shelled corn, but certain precautions must be taken in feeding it. When stored for a time it has a tendency to generate heat, with the consequent formation of mold. It is therefore best to grind the grain only as needed.

Wheat.—Under ordinary conditions wheat is relatively too high in price to permit its economical use in the horse ration. If conditions permit, however, wheat may be satisfactorily used for horses provided it is crushed or rolled and fed in moderate quantities. Crushing or rolling is necessary because horses can not efficiently chew the whole, hard grains, and a limitation of the amount fed is essential to prevent digestive disturbances. Compared with corn, wheat carries slightly more carbohydrates, more crude protein, but less fat. The most satisfactory feeding results will be obtained when wheat is fed in conjunction with a bulky concentrate and when the roughage is of protein nature, rich in mineral matter, as alfalfa.

Wheat bran.—This is a favorite feed among horsemen because it is especially palatable and safe. A by-product of milling, bran is usually somewhat expensive and is not always readily available. Wheat bran is quite laxative, and for this reason it is especially valuable for pregnant mares, idle horses, and colts. With horses doing irregular work, the movement of the bowels may be regulated by increasing or decreasing the allowance of bran. Because this feed is light and soft in character it makes a good mixture with other feeds, often making them more suitable for feeding. Wheat bran is very nutritious; it is higher in protein than either oats or corn. However, it is not suited to form the entire concentrate ration for horses because it is too bulky and is somewhat deficient in lime.

Barley.—Barley is used as a principal grain for horses in many parts of the West. Except in physical character it is well suited to the horse ration. This grain should be rolled before being fed. If finely ground it will form a pasty mass with the saliva of the mouth. Barley is a little higher in total nutrients than oats, but is not so widely used nor so generally popular a feed among horsemen. Rolled barley is suitable to form the major part of the grain ration for horses.

Rye.—This may be used as a horse feed in combination with other grains. In some regions it is an economical feed. It is even higher in total nutrients than oats. The grain is small and hard and should be rolled or ground. Many horses will refuse whole rye when fed alone, and an abrupt change to rye feeding is liable to produce colic. Most of the charges against rye may be traced to the feeding of moldy or otherwise damaged grain. It is probably better to limit the amount of rye to one-third of the grain ration. It may be mixed with ground corn, bran, oats, or other grains. Rye is not generally considered desirable to form a major part of the grain ration for horses, as it is not palatable when fed alone and is liable to cause digestive disturbances.

Buckwheat.—This grain is not very commonly used as a horse feed, although it is only a little below the more common cereals in total digestible nutrients. It has a characteristic, hard, black hull which has practically no value as a feed. Unadulterated buckwheat middlings are not easily obtained. They are made from that part of the kernel just beneath the woody hull and are very rich in protein. The common practice is to mix the middlings with the woody hulls and sell it as buckwheat feed or buckwheat bran. This product has a lower feeding value than wheat bran. If the proportion of hulls is not too large, buckwheat bran may be well used in the horse ration. Buckwheat should be limited to one-third the grain ration.

Rice.—Rice is considered economical for horse feed in some of the Southern States, the less valuable kind of rough rice being used. This grain is small and extremely hard; it should be ground or rolled before use in the horse ration. It is better to limit rough rice to one-third of the grain allowance. Rice may be used in connection with corn, blackstrap molasses, and a very limited allowance of some protein concentrate, such as cottonseed meal, soy-bean meal, or linseed meal.

Soy beans, cowpeas, velvet beans, horse beans, field peas.—All these are similar seeds of leguminous plants, and are suitable for use in limited amounts in the horse ration. Since all are hard

seeds, they should always be ground. Their proper use in a ration for horses is as a somewhat concentrated protein feed to be combined with feeds high in carbohydrates, such as molasses and corn. Digestive troubles are very liable to occur if one or more of these feeds exceed one-third of the concentrate ration. Used with care they have a very valuable place in horse feeding.

Coconut meal.—A by-product from the manufacture of coconut oil, coconut meal is considered a safe but rather unpalatable feed for horses. It is a little higher in nutrients than wheat bran, but has the disadvantage of becoming rancid after standing a few weeks. To the extent of one-fourth of the grain ration it may replace oats where economy justifies the measure. Coconut meal is not a very heavy protein concentrate.

Peanuts.—In the form of peanut meal this feed is often given to horses. Shelled peanuts are liable to become rancid if stored for any length of time. The commercial form of peanut meal is the ground hull and kernel combined. It is a comparatively safe feed for horses, but is so rich in protein that the allowance should be limited. When it is used, animals should be started on this feed gradually and it should be fed in connection with corn or some other carbonaceous feed.

Linseed meal.—This feed is the ground cake resulting after the oil has been extracted from flaxseed. It is very high in protein, has laxative properties, but is not suited to form the bulk of the grain ration. Linseed meal is quite unpalatable, but is valuable, however, for combining with corn and other carbonaceous feeds, being a heavy protein concentrate. It is most successfully fed with ground feeds or in a mixture containing molasses, for if fed in combination with feeds from which it can be separated readily, horses will eat the palatable grains and refuse the meal. Some feeders use linseed meal as a conditioner, giving a small amount (about one-half pound) three times a week to keep the bowels in free condition. The more favorable results in the use of linseed meal are obtained when the quantity used is limited to 1 pound or less per day for each animal.

Shorts (wheat middlings).—This is not extensively used as a horse feed because it is usually high in price and its heavy nature and high protein content make it unsuitable to form the major part of the ration. It is palatable, however, and may be used to supplement a horse ration that is low in protein. The quantity should be limited to one-fourth of the concentrate allowance.

Cottonseed meal.—The resulting ground cake after the oil has been extracted from the cottonseed is a heavy protein concentrate which, unlike linseed meal, is not laxative in character. This feed has met with considerable disfavor among horse feeders, as it is believed to have a tendency to produce digestive disorders. There is no doubt some foundation for this belief, but it has been found that the harmful results have usually followed either the use of a poor quality of meal or the feeding of too much. Cottonseed meal may be fed to horses in limited quantities if due care is exercised in obtaining bright, choice meal and if the animals are put on the diet gradually. Its proper use is as a supplement to a carbonaceous concentrate, such as corn. Favorable results have been obtained in some parts of the South in the feeding of cottonseed meal in connection with blackstrap molasses and grain. Since the meal is not palatable, it should be well incorporated with other feeds. While cottonseed meal has been fed in large quantities in isolated cases, the best results may be obtained by limiting the amount to 1 pound daily per 1,000 pounds live weight, and giving special attention to the horses being fed.[3]

Alfalfa meal.—Chopped alfalfa is often desirable to improve the physical character of a ration, but feeding alfalfa as a meal is not to be generally recommended. Alfalfa is a very valuable horse feed but is properly classed among the roughages, even though it is higher in nutrients than some of the concentrates. Finely ground alfalfa is dusty and must be dampened before it can be fed with satisfaction. There is no advantage which justifies the additional cost of grinding, except for horses with bad teeth or weak digestive organs.

Millet, kafir, and milo seeds.—These are very small, hard grains which must be ground before they are suitable for the horse ration. They compare favorably with oats in regard to total nutrients, and any of them, when ground or rolled, may be used in combination with other grains, but it is

[3] For further information, refer to U. S. Department of Agriculture Bulletin 929. Cottonseed Meal for Horses. Out of print, but may be consulted in libraries.

well to limit the amount used to one-third the total concentrate allowance. The sorghum grains are high in carbohydrates and tend to cause constipation when fed heavily. These grains, therefore, should be fed in conjunction with a laxative protein feed, such as wheat bran, to counteract this tendency.

Dried brewers' or distillers' grains.—These grains, which are by-products of fermentation industries, are rather heavy protein concentrates and suitable for balancing carbonaceous rations or for incorporation with chopped mixtures, but are not suitable for use as the major part of the grain ration. They are not palatable and should be limited in amount to about one-fourth the total allowance of concentrates. Some feeders claim that these feeds have a tendency to cause constipation.

Gluten meal.—A by-product of starch manufacture, it is high in protein and fairly high in carbohydrates. It is classed as a protein concentrate, and should be limited to about one-fourth the total grain allowance. It is not very palatable, but sometimes is valuable for use in chopped mixtures.

Gluten feed.—This is also a protein concentrate but is somewhat less nutritious than gluten meal. Gluten feed is made by mixing corn bran with gluten meal, and is not very palatable. The proper use of gluten feed is for balancing more carbonaceous rations, and it should be limited in amount to one-third of the grain ration. Like gluten meal, it may well be used with other grains in a chopped mixture and fed with molasses.

Dried beet pulp.—A by-product of sugar manufacture, this pulp is unpalatable, but by mixing with molasses or other well-liked feeds, it may be included in the ration. It is very low in protein. Dried beet pulp is a safe feed, but it is not desirable to use it in excess of about 5 pounds in the daily ration, and it should be fed in connection with some feed that is relatively high in protein.

Cane molasses (blackstrap molasses).—The use of this feed is quite popular in cane-growing sections. It is high in carbohydrates and should be fed in connection with feeds relatively high in protein. Molasses is especially palatable and is well suited for combination with chopped mixtures containing nutritious but unpalatable feeds. It is usually desirable to dilute it with two parts of water before feeding over grain or roughage. The amount of molasses in the ration should be limited. Usually about 5 pounds daily is a very reasonable allowance, although some feeders use considerably more than that amount. Cane molasses is neither laxative nor binding in effect. Molasses is not usually an economical feed except in sugar-producing regions. However, it is often desirable to use a small amount, such as a quart (3 pounds) a day, as an appetizer.

Beet molasses.—As a horse feed, beet molasses is not so satisfactory as cane molasses. The presence of certain constituents stimulates the action of the kidneys and bowels of the animals fed. Because of this action it is not desirable to exceed 5 pounds of beet molasses in the daily ration. Like cane molasses, it is a carbohydrate concentrate, very palatable and suitable for feeding as part of a concentrate ration that also includes a protein feed.

Milk.—Sometimes milk may be used with good results for feeding horses. Its particular advantage is in its use for colts and for horses that are out of condition. Milk may also be a valuable feed for horses doing very light work. It is palatable, easy to digest, and valuable for fattening. If cow's milk is to be substituted for mare's milk for young colts, there should be an addition of a little sugar and a little limewater. It is not desirable to feed a large quantity of milk to horses generally, but 3 or 4 gallons a day can well be allowed a horse not doing heavy work. Milk is a safe feed, and even in clabbered condition it is not harmful.

Tankage and blood meal.—These by-products of slaughterhouses do not rank high as horse feeds. They are very high in protein, but are extremely unpalatable. They may be used, however, in amounts not exceeding 1 pound each day per animal in connection with some palatable carbonaceous mixture. Tankage and blood meal are used principally for young stock and for building up animals in extremely poor condition.

ROUGHAGES

Alfalfa hay.—This roughage is receiving very great favor as a horse feed. It contains nearly as much nutriment, pound for pound, as wheat bran. It is very high in protein and minerals; hence it is especially valuable for young stock. Alfalfa is somewhat laxative in effect. Because of this and its high protein content, it is well to limit the amount to one-half or two-thirds the roughage allowance. Tim-

othy hay may be used to make up the rest of the roughage supply. Alfalfa is especially suited for use with a grain ration that is low in protein. Corn as the grain, and alfalfa as the roughage, equal weights of each, very nearly make a balanced ration. In considering a roughage for horses, it is desirable to furnish one that is relatively high in nutriment, since the horse has a comparatively small stomach and is unsuited to take care of great quantities of nonnutritious material. Alfalfa meets this requirement. Because of its soft stems this roughage is often used in chopped mixtures.

Timothy hay.—This hay is highly recommended for horses. Notwithstanding the fact that it is not very high in nutrients, there is probably no other one form of roughage that is better suited for the horse ration. It is low in protein and is suitable for combination with alfalfa, clover, or some other legume. If timothy is fed as the only form of roughage, the concentrate allowance should be relatively high in protein. Because of its sharp, brittle stems it is not well suited for use in chopped mixtures. It is readily available in most sections of the country. Timothy hay and oats have long been regarded as the standard horse feeds, but the combination can be improved by including some feed that is relatively high in protein.

Clover hay.—This is a good feed for horses. The usual criticism of this hay is that it is often dusty. Dampening at the time of feeding will aid somewhat, but proper care in the curing of the hay is the best means of preventing dust. Bright clover hay that is free from dust is almost as valuable as alfalfa. It is more palatable than timothy, and a mixture of clover and timothy is to be preferred to timothy alone as a roughage for horses. Clover is a legume, high in protein, somewhat laxative in effect, is an excellent feed for colts, and is suited for use in connection with a grain ration that is rather low in protein. Where only one kind of hay is fed, a smaller quantity is required of clover than of timothy. Various kinds of clovers are used for hay in different parts of the country. Common red clover is most widely used. Mammoth or Big English clover is acceptable, but is somewhat coarse. The very coarse, large varieties, such as sweet clover, are usually too woody to be very desirable. Alsike is very good, but the yield of this crop is usually not large enough to encourage its growth in most localities. If hay from crimson clover is to be used as a horse feed, the crop should be cut before the blossoms are ripe, as the hairy growth on the head of the plant becomes wiry and indigestible and forms masses similar to hair balls, in the digestive tract, which often result in serious cases of impaction. Bur clover of the South may be used as a hay for horses, but its use is not common.

Corn stover.—Corn fodder from which the grain has been removed is a common feed for horses. The objections to it are that it is usually so carelessly handled that most of the nourishment is lost, and that the feed is allowed to become partly spoiled. It is also unhandy to feed unless some special preparation is given, and there is usually considerable waste connected with feeding it. However, corn stover that is bright and clean and which retains its leaves is very palatable, desirable, and safe for horses, and is suitable for use as the sole roughage during the fall and early winter. It is low in protein and should be fed in combination with a concentrate ration which will offset the deficiency. Cutting or shredding is usually advisable if it is to be fed in the stable.

Oat hay.—Hays from oats and similar cereals are commonly fed to horses. These crops should be cut before maturity if they are to be used as forage. They are palatable and nourishing, and care should be taken that the amount is limited. On account of the grain, the allowance should be about one-third less than would be fed in the case of the more common roughages. Very little concentrated feed is needed with oat hay, but it is desirable to include a feed relatively high in protein. Cereal hay may be fed as half the roughage allowance in connection with a legume hay. With such a combination only about half the usual grain ration is necessary.

Cowpeas, soy beans, velvet beans, and field peas.—These may be used as hay for horses. All are legumes, high in protein, and suitable for use in connection with concentrates that are high in carbohydrates, such as corn or molasses. The peas and beans are slightly laxative in effect. It is well to limit these feeds to one-half the roughage allowance; timothy or prairie hay may well be used to form the other half. The amount of grain in the pods should be taken into consideration, and the ration of concentrates should be reduced accordingly.

Field-pea vines that have been carefully cured after the peas have been threshed out are fairly acceptable as horse forage. A full grain ration and a little hay should be fed with them. Unthreshed cowpeas, soy beans, velvet beans, and field peas are safe and fairly palatable feeds, but are too concentrated to form the complete roughage allowance.

Millet, or Hungarian hay.—This is suitable for use in the horse ration, provided the crop has been cut before it is too mature and that an excessive quantity is not fed. The small, hard seeds of mature millet are objectionable, as harmful action on the kidneys is claimed when an excess of these is fed. This hay is carbonaceous in character and should be fed in connection with a legume hay, or the concentrate allowance should contain feeds a little high in protein. Bright millet hay of fine growth is quite satisfactory as a horse feed when limited to half the roughage allowance.

Prairie hay.—This hay is satisfactory for use as a horse feed and is commonly used in the West. It is slightly lower in nutrients than timothy hay, is carbonaceous, and should be fed in combination with a legume hay. It is a safe feed, fairly palatable, and may form the total roughage allowance if the concentrate ration is sufficiently high in protein.

Orchard-grass hay.—Orchard grass makes a suitable hay for horses only when it is cut before maturity. It compares very favorably with timothy, and its palatability is not criticized in hay that is not too mature when cut. It is carbonaceous, and when used either the concentrates should be high in protein or a legume hay should form part of the roughage allowance. It is a safe feed for horses.

Johnson-grass hay.—In certain sections of the South, particularly throughout the Cotton Belt States, Johnson grass grows luxuriantly, often producing three cuttings of good hay a year and forming excellent pasturage. In this district this grass may be utilized to advantage as forage for horses. Johnson grass is a carbonaceous roughage which has a feeding value equivalent to timothy, is slightly laxative in character, and is eaten with relish by horses. The principal drawback to feeding Johnson-grass hay in those sections where clean cultivation of other crops is practiced lies in the fact that such feeding distributes the seeds of the plant and makes the confinement of its growth to a limited area very difficult.

Brome grass.—This grass is of carbonaceous character and is common in the North and West. The hay is palatable and safe for horses. It is a little low in protein, and the grain ration that is fed with it should include a protein concentrate.

Straw.—Straw from various cereals such as oats, barley, wheat, rye, and rice, is often used as a feed for horses. It is bulky, nonnutritious, and is not especially suitable, since the horse has a comparatively small stomach and its digestive anatomy is in no way suited to handle a large amount of bulky feed. So very little nourishment is derived from straw that it is not considered a suitable feed for animals doing hard work. Straw is carbonaceous, and its principal use is for idle horses. Some laxative feed should be fed in connection with it. Because of economy, it is often desirable to feed some straw, and in this case the concentrate allowance should be high in protein. A little straw may be included in a ration in which the principal roughage is alfalfa, clover, or some other legume. Oat straw is preferable; barley straw and wheat straw are good; straw from buckwheat or rye is not desirable; straw from rice is sometimes fed with good results when the remainder of the ration is high in protein. The economy of feeding straw is a factor which can not be disregarded, but the practice should not be carried to the extreme, and care should be taken to supply sufficient protein through the concentrate ration.

Vetch.—This legume is not very commonly used as a horse feed. The plant is rich in nutrients, is suitable to form about half of the roughage allowance in a ration that is lacking in protein, and is fairly palatable. A combination that is meeting with favor is vetch and oat hay.

Sudan grass.—This plant makes a suitable hay for horses and is fairly palatable. As a carbonaceous feed the hay is suitable for use as part of the roughage allowance in combination with a legume hay. Its principal use is in the South.

Bermuda grass.—Hay from this plant is sometimes used in the South. It is a carbonaceous feed, suitable for use in connection with legume hay for the roughage allowance. If fed alone

the concentrate allowance should be high in protein.

Sorghum.—Fodder from sorghum may be used as dry forage for horses but does not keep for a great length of time. It is especially high in carbohydrates, is palatable and suitable for use in connection with feeds which are high in protein.

Pumpkins.—As a succulent feed for horses, pumpkins have a fair value, their feeding value being about two-fifths that of silage, and their main use for improving digestion. The seeds have a laxative effect. It is not advisable to feed pumpkins which have been frosted. They are not usually fed in great amount and should be limited to about 8 pounds daily. No other laxative feed should be included in the same ration, there should be a slight decrease in the amount of roughage, and provision should be made for feeds relatively high in nutrients to balance the ration.

Silage.—Silage should not be considered as one of the principal roughages for horses. Its use is as a succulent, an appetizer, and tonic to be fed in limited quantities as a supplement to the regular ration, preferably for idle horses. When used, this feed must be introduced gradually into the ration. It is a very dangerous practice to feed moldy or frozen silage to horses. Corn silage is the only kind that has met with any degree of favor as a horse feed. It has a valuable place in the winter ration if fed with care. The amount should not exceed 10 pounds daily per animal.

WATER

There is a diversity of opinion among horsemen on the question of watering horses. Some feeders maintain that horses should always be watered before feeding in order to prevent a flushing of the grain through the stomach into the small intestine. This system is not always practicable, however, as some animals will refuse to drink before eating. The consensus of opinion on watering horses indicates that water may be given either before, during, or after meals without injurious effects. Thus, individual convenience and attendant circumstances will largely determine the watering practice to be followed. In any practice, however, it is well to adhere to the same plan, once a definite watering time has been adopted, for to change frequently from one system to another will affect the animal's appetite. Regularity in watering methods as well as feeding methods should be adhered to.

The following factors should be considered in watering horses:

Horses which have been deprived of water for a long period or those which have undergone severe exertion should generally be watered before eating. It is dangerous, however, to allow an animal to drink heavily while very warm. If the horse is hot, give a moderate drink at this time, and water more freely when the animal is cool.

It is not a good practice to water heavily just before putting horses to heavy work.

Weather conditions, the nature of the work done, and the kind of feed consumed will determine the quantity of water required. In hot weather and when at hard work, horses consume more water than in cold weather or when inactive. Horses will drink more water when fed a protein-rich ration, such as alfalfa hay, than when on a carbonaceous diet.

The average water consumption per individual horse is from 10 to 12 gallons daily.

One of the times when a horse requires and appreciates a drink most is when it has finished its nightly allowance of roughage. Every horse should be allowed to drink at this time if possible.

Horses at hard work in hot weather should be watered hourly. It is better to water frequently, in small quantities, than to allow the animal to gorge itself at any one time.

Watering at public troughs is to be avoided, as this is a common method of spreading disease.

SUCCULENT FEEDS

Pasture.—Pasture is foremost among the succulent feeds for horses. It acts as a laxative and general tonic to the system, is an appetizer, and a valuable feed. Succulent feeds are watery and do not produce solid flesh. While pasture alone is sufficient to maintain idle horses, it is well to consider the relative feed value of the pasture crop and the general condition of the pasture. Usually it is advisable to feed a light grain ration relatively high in protein in connection with pasture, even when the horses are idle. Pasture is very valuable in the management of work teams; regularly allowing horses the freedom of pasture during the night and on idle days enhances the health of the animals. There will be an increased tendency

toward sweating while at work but this is not of great importance when the benefits are considered. For work horses that are given pasture, other laxative feeds should be taken out of the ration. Timothy hay may be used as the roughage, and the concentrate allowances should include grains that are not laxative in character, thus making a properly balanced ration. A necessary precaution is to avoid a sudden change to green feed; where a pasture crop is included in the ration for work horses, the pasturing should be continuous, not intermittent.

Soiling crops.—Most of the forage crops previously mentioned under "Roughages" may be cut green and fed to horses. This practice is probably most common with corn. Care should be taken, however, to prevent sudden changes to this type of green feed. There is also danger of the crop's spoiling before being fed; therefore, the green feeds should be used only when fresh. The balancing in regard to nutrients should be the same for soiling crops as for pasture. The pasture system provides exercise and on this account is far preferable to soiling.

Roots.—Carrots, parsnips, rutabagas, and beets are succulent feeds used principally as an aid to digestion. Their use in the horse ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed other laxative feeds should be omitted, the roughage supply should be decreased, and the grain ration should contain feeds high in nutrients. Chopping the roots is usually advisable.

Potatoes.—Potatoes are relatively high in food value, are palatable, and are well suited for use as a horse feed where the cost is not prohibitive. It is safe to feed as high as 15 pounds a day to work horses. They are equivalent to about one-third their weight in hay. When potatoes are fed, a legume hay is a desirable supplement. If a carbonaceous hay is fed, the grain ration should contain feeds rich in protein. Potato sprouts are injurious to horses and should be removed. It is advisable to chop potatoes before feeding, as the danger from choking is thereby lessened.

Fruits.—When without stones, fruits may be used for feed and are much relished by horses. This addition to the ration is as an appetizer and relish rather than as a nutritious feed. Fruits are low in protein, and if used in considerable amount the main ration should be nitrogenous in character. Ten pounds of fruits daily are not harmful.

SALT

Horses should be given salt at frequent, regular intervals, or, better, salt should be accessible in the feed boxes, pastures, and paddocks at all times. When salt is given regularly, only enough to meet the body requirements will be consumed. With irregular use, however, an abnormal appetite for salt develops, which, in turn, is often followed by excessive consumption and digestive troubles. An average of about 1½ ounces daily should be allowed most horses under normal conditions. Horses doing heavy work, particularly during hot weather, and those on dry feed will consume more than this quantity.

Aside from its value as a feeding requisite, salt is of benefit as an appetizer, for in many instances delicate eaters and shy drinkers will show an increased appetite when allowed free and regular access to it. Moreover, the consumption of adequate quantities of salt by work horses will do much in preventing excessive fatigue.

STOCK FEEDS AND CONDIMENTS

The stock and condimental feeds that are generally bought on the market, which are represented to be conditioners, tonics, and fatteners, have for their foundation simple, well-known drugs, and feeds. If a tonic or feed is desired, one of known composition may be mixed at home with entirely satisfactory results. The following formulas are suggested:

I	
Glauber salt	2 pounds.
Soda	1 pound.
Salt	1 pound.
Fenugreek	2 ounces.
Linseed meal	25 pounds.

II	
Glauber salt	5 pounds.
Saltpeter	1½ pounds.
Fenugreek	1 pound.
Gentian	2 pounds.
Linseed meal	50 pounds.

A heaping tablespoonful of one of the foregoing mixtures fed with the grain three times a day is sufficient.

When a tonic is needed it is advisable to investigate why it is needed. The horse should receive daily attention regarding feed, water, salt, exercise, grooming, sanitation, and comfortable quarters. Neglect of any of these factors is usually an underlying cause of the poor condition of an animal.

SUGGESTED DAILY RATIONS

The following daily rations have been prepared with a view of suggesting combinations of feeds that will suit conditions in various parts of the country, and from which the feeder may derive rations that will meet his local needs. Attention is invited to the fact that the rations suggested are for a horse weighing 1,000 pounds, and modification of these rations should be made for heavier or lighter horses. For example, in order to meet the requirements for a horse weighing 1,250 pounds the rations suggested should be increased in accordance with the increase in weight, which in this case is 25 per cent. Roughly this would give the feed requirement for the heavier horse.

Maintenance rations for 1,000-pound idle horse

[Theoretical daily requirement, 0.60 pound of protein and 7.30 therms of energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
5 pounds ear corn	0.280	3.420	4 pounds rolled barley	0.332	3.5976
3 pounds alfalfa hay	.213	1.0269	4 pounds alfalfa hay	.284	1.3692
9 pounds corn stover	.144	2.8458	7 pounds barley straw	.042	2.5627
	.637	7.2927		.658	7.5295
4 pounds oats	.348	2.7024	4 pounds alfalfa hay	.284	1.3692
4 pounds clover hay	.196	1.5472	14 pounds corn fodder with ears	.322	6.1516
10 pounds oat straw	.08	3.481		.606	7.5208
	.624	7.7306			
			2 pounds shelled corn	.140	1.710
8 pounds alfalfa	.568	2.7384	4 pounds oat hay	.156	1.290
8 pounds oat straw	.064	2.7848	10 pounds orchard-grass hay	.330	4.493
3 pounds cane molasses	.000	1.6614		.626	7.493
	.632	7.1846			
			3½ pounds shelled corn	.245	2.9925
5 pounds cowpea hay	.460	1.8795	3 pounds cowpea hay	.276	1.127
5 pounds silage (corn)	.030	.7950	10 pounds oat straw	.08	3.481
10 pounds timothy hay	.220	4.3020		.601	7.60
	.710	6.9765			

Daily rations for 1,000-pound horse, very light work

[Theoretical requirement, 1 pound protein and 9.80 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
10 pounds ear corn	0.56	6.840	5 pounds shelled corn	0.35	4.275
5 pounds alfalfa hay	.355	1.711	2 pounds cowpeas	.338	1.5892
5 pounds timothy hay	.110	2.151	½ pound cottonseed meal [1]	.177	.4672
			5 pounds corn stover	.08	1.581
	1.025	10.702	5 pounds sorghum fodder	.075	1.610
				1.020	9.5220
8 pounds oats	.696	5.4048			
4 pounds alfalfa hay	.284	1.3692	7 pounds shelled corn	.490	5.985
6 pounds timothy hay	.132	2.5812	1 pound cottonseed meal	.354	.934
			4 pounds cowpea hay	.368	1.5088
	1.112	9.3552	6 pounds corn stover	.096	1.8972
				1.308	10.3380
5 pounds cowpeas (coarsely ground)	.845	3.9730			
5 pounds molasses	.000	2.7690	8 pounds shelled corn	.560	6.840
10 pounds oat straw	.080	3.481	4 pounds cowpea hay	.368	1.5088
			6 pounds corn stover	.096	1.8972
	.925	10.223		1.024	10.2460
8 pounds rolled barley	.664	7.1952			
4 pounds alfalfa	.284	1.3692			
5 pounds prairie hay	.145	2.021			
	1.093	10.5854			

[1] The meal may be replaced by 1 pound of cowpeas.

Daily rations for 1,000-pound horse at medium work

[Theoretical requirement, 1.40 pounds protein and 12.40 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
13 pounds ear corn	0.728	8.892	11 pounds shelled corn	0.770	9.405
6 pounds alfalfa hay	.426	2.0538	6 pounds cowpea hay	.552	2.2554
7 pounds timothy hay	.154	3.0114	6 pounds corn stover	.096	1.8972
	1.308	13.9572		1.418	13.5576
12 pounds oats	1.044	8.1072	5 pounds cowpea hay	.460	1.8795
1 pound cowpeas (cracked)	.169	.7946	9 pounds corn stover	.144	2.8458
11 pounds timothy	.242	4.7322	10 pounds shelled corn	.700	8.550
	1.455	13.6340	½ pound cottonseed meal	.177	.4673
				1.481	13.7426
10 pounds rolled barley	.83	8.9940			
6 pounds alfalfa hay	.426	2.0538			
5 pounds prairie hay	.165	2.021			
	1.421	13.0688			

Daily rations for 1,000-pound horse at severe work

[Theoretical requirement, 2 pounds protein and 16 therms energy]

Rations	Protein	Energy	Rations	Protein	Energy
	Pounds	*Therms*		*Pounds*	*Therms*
12 pounds oats	1.044	8.1072	10 pounds rolled barley	0.830	8.9940
2 pounds bran	.216	1.0600	2 pounds gluten meal	.562	1.6830
8 pounds timothy hay	.176	3.4416	8 pounds alfalfa	.568	2.7384
5 pounds clover hay	.245	1.9340	6 pounds prairie hay	.174	2.4252
	1.681	14.5428		2.134	15.8406
12 pounds shelled corn	.840	10.260	5 pounds cowpea hay	.460	1.8795
1 pound soy beans (ground)	.273	.8129	9 pounds corn stover	.144	2.8458
12 pounds alfalfa	.852	4.1076	13 pounds shelled corn	.910	11.115
4 pounds corn stover	.084	1.2648	1½ pounds cottonseed meal	.531	1.4019
	2.049	16.4453		2.045	17.2422
7 pounds peanuts (ground with hull)	1.183	5.8205			
7 pounds cane molasses	.000	3.8766			
7 pounds pea hay	.644	2.6313			
7 pounds timothy hay	.154	3.0114			
	1.981	15.3398			

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